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La Sal Collaboration (LSSC): Final Report and Consensus Recommendation

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La Sal Sustainability Collaboration (LSSC)

Final Report and Consensus Recommendations
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Photo Credit: Bracken Davis

Jointly convened by the Utah Department of Agriculture and Food and the Grand Canyon Trust

Report compiled by Michele Straube, University of Utah and LSSC Members

Utah Department of Agriculture and Food
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WILDLIFE RESOURCES

GRAND CANYON TRUST

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Members of the Collaborative Group

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Wallace Stegner Center for Land, Resources and the Environment
University of Utah S.J. Quinney College of Law

La Sal Sustainability Collaboration

FINAL REPORT and CONSENSUS RECOMMENDATIONS

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EXECUTIVE SUMMARY

The La Sal Sustainability Collaboration (LSSC) was established in response to social, economic, administrative, and ecological concerns for a 285,000 acre landscape in the southern La Sal Mountains and adjoining canyon lands. LSSC is co-convened by the Utah Department of Agriculture and Food (UDAF) Grazing Improvement Program and the Grand Canyon Trust (GCT). Other consensus-seeking members of the LSSC include San Juan County, the Sierra Club (SC), Trout Unlimited (TU), the Utah Division of Wildlife Resources (DWR), La Sal Livestock, and BLT Livestock. All LSSC members, except the Sierra Club, have signed this Final Report and Consensus Recommendations. Representatives of federal agencies and other various state agencies provided invaluable service in an advisory capacity.

The purpose of the Collaboration is to co-create an approach to management of the LSSC area where federal, state, and private lands are operated as an integrated, sustainable system. The Collaboration's initial goal was to develop consensus recommendations that will provide for **ecological resilience**, sustain **economic viability**, promote **cultural preservation**, and be **socially acceptable** and **legally defensible**. Some of the consensus recommendations will be presented for agency decision-making, and some can be implemented independently. After working together for over two years, the LSSC members also made a commitment to an active role in the evaluation, refinement, and implementation of their recommendations, and ongoing assessment and improvement of management of the LSSC landscape.

LSSC members[1] reached consensus recommendations in three broad categories. Recommended **Management Actions** were developed relative to livestock grazing, native fish conservation, beaver reintroduction, restoration of upland forest health, the role of wildland fire, limiting soil erosion, protection of high value areas, and mitigation of social conflicts. **Administrative Actions** related to operational issues, the regulatory status of cutthroat trout in Beaver Creek, and communication effectiveness are recommended. Finally, this report recommends a number of actions for **Assessing Progress and Promoting Accountability,** including: adoption of a comprehensive suite of desired conditions/indicators and associated monitoring plan; an adaptive management strategy; a drought management plan; and performance incentives. Recommendations for the ongoing role of the LSSC in the evaluation, refinement, and implementation of recommendations, and ongoing assessment and improvement of management of the LSSC landscape, are also included.

[1] The Sierra Club submitted a separate statement in lieu of signature.

I. INTRODUCTION

The La Sal Sustainability Collaboration (LSSC) was established in 2014 in response to social, economic, administrative, and ecological concerns for the southern La Sal Mountains and adjoining canyon lands. This 285,000 acre landscape includes private lands and public lands managed by the Bureau of Land Management (BLM), U.S. Forest Service (FS), and the Utah School and Institutional Trust Lands Administration (SITLA). LSSC is co-convened by the Utah Department of Agriculture and Food (UDAF) Grazing Improvement Program and the Grand Canyon Trust (GCT).

A. MEMBERSHIP. In addition to the UDAF Grazing Improvement Program and the Grand Canyon Trust, other consensus-seeking members of the LSSC include San Juan County, the Sierra Club (SC), Trout Unlimited (TU), the Utah Division of Wildlife Resources (DWR), La Sal Livestock and BLT Livestock. Representatives of the BLM, FS, SITLA, and the Natural Resource Conservation Service (NRCS) regularly attended LSSC meetings in an advisory capacity. Representatives of the US Fish & Wildlife Service and San Juan Soil Conservation District also served in an advisory capacity, and attended select meetings when issues relevant to their jurisdiction were discussed.

B. PURPOSE and GOAL. The purpose of the Collaboration is to co-create an approach to management of the LSSC area where federal, state, and private lands are operated as an integrated, sustainable system. The Collaboration's goal is to develop consensus recommendations that will:

1. Provide for **ecological resilience**
2. Sustain **economic viability**
3. Promote **cultural preservation**
4. Be **socially acceptable** and **legally defensible**

C. KEY ISSUES. Dialogue among LSSC members led to identification of a key suite of issues they sought to address, within four broad categories: Social, Economic, Administrative, and Ecological.

1. **Social**
    - Conflict over the presence of cattle in the Pack Creek residential area
    - Interaction among various public land multiple uses result in diminishment of values important to those users
    - Opportunity for future generations to graze livestock on public lands

2. **Economic**
    - Costs associated with management (public and private)
    - Livestock production quantity and reliability
    - Inadequate water, cross-fencing, and other infrastructure to effectively manage forage use by livestock
    - Potential to capture other economic values
3. **Administrative**
    - Permit/Authorization transfer, modification and compliance
    - Inter- and intra-agency coordination and communication with permittees
    - Regulatory status of native cutthroat trout in Beaver Creek
4. **Ecological**
    - Biological diversity of native flora
    - Biological diversity of native fauna
    - Watershed health – riparian/aquatic
    - Watershed health – upland forest health/uncharacteristic wildfire
    - Watershed health – soil stability and productivity
    - Watershed health – invasive species

D. FACILITATION. LSSC meeting facilitation and note-taking was provided by the Environmental Dispute Resolution (EDR) Program, Wallace Stegner Center for Land, Resources and Environment, S.J. Quinney College of Law at the University of Utah.

E. APPROACH.

1. **Conveners and Participants.** The La Sal Sustainability Collaboration ("LSSC") was convened in August 2014. Utah Department of Agriculture & Food (Grazing Improvement Program) and Grand Canyon Trust acted as co-conveners, issuing an invitation to a cross-section of interests to participate in the collaborative effort.

Eight entities became members of the LSSC, with the right and responsibility to participate in consensus decision-making. In addition to the co-conveners, LSSC members included representatives from the two grazing permittees in the LSSC geography (La Sal Livestock and BLT Cattle), San Juan County, UT Division of Wildlife Resources, and conservation groups (Sierra Club and Trout Unlimited). Multiple entities participated in all collaboration activities as resource experts, serving as a technical resource to inform the group's discussions and agreements, but not official participants in the collaboration's consensus-building process. LSSC resource experts included representatives from the US Forest Service (FS), Bureau of Land Management (BLM), Natural Resources

Conservation Service (NRCS), UT School Institutional Trust Land Administration (SITLA), San Juan Soil Conservation District, and US Fish & Wildlife Service (F&WS).

A full listing of the original collaboration participants can be found in **APPENDIX A**. There was turnover in representation for one LSSC member and several resource experts over the course of the collaboration's active negotiations.

2. **LSSC Purpose.** The group's first meetings were used to decide on a common purpose, described in the Operating Protocols as follows:

> The purpose of the Collaboration is to co-create an approach to management of the area referred to as "Southern La Sal's and Canyons"[1] where federal, state and private rangelands are operated as an integrated, sustainable system. The LSSC's recommendations will (1) provide for ecological resilience, (2) sustain economic viability, (3) promote cultural preservation, (4) be socially acceptable, and (5) be legally defensible.
>
> We recognize the importance of this difficult task, and choose to approach it as a collaborative effort, believing that input from a variety of government and private entities will ensure the best available resources and knowledge to work towards our shared goal of productive and resilient rangelands, [2] and strengthened relationships.

The collaboration's desired outcome was to "develop consensus recommendations for collaborative solutions, some of which will be presented for agency decision-making and some of which can be implemented independently."

3. **Operating Protocols / Consensus-Based Decision-making.** The LSSC developed Operating Protocols to guide the group's work. In addition to ground rules designed to foster respectful dialogue, the group agreed that they were "working together to gain a better understanding of the various logistical concerns, interests, and perspectives at issue," which would be used to "brainstorm creative solutions that best meet the needs of the various interest groups and the land in question."

[1] See maps in Appendix B for area covered by this name.

[2] "Rangeland" is characterized by native plant communities that will provide the necessities of life for grazing and browsing animals, and is managed by ecological, rather than agronomic, methods. Range resources are not limited to the grazeable forage, but include wildlife, water, vegetative species diversity, and many other benefits. Grass-lands, desert shrublands, savanna woodlands, forests, and tundra are the basic rangeland types of the world. [references available in Appendix A]

The group chose consensus decision-making as the process most likely to help them find common ground. Rather than using a vote or veto process, consensus requires that everyone agrees they can accept what has been proposed. As a part of the process to reach consensus, the interests of all participants must be fully explored and understood, and every effort must be made to explore options that meet the interests of all participants. Each collaboration participant shared the responsibility to propose solutions that met everyone else's interests as well as their own, and conversation continued until a mutually acceptable solution was identified.

The Operating Protocols can be found in **APPENDIX A**.

4. **LSSC Activities**. The lengthy discussions about the LSSC purpose in its first meetings provided an opportunity for mutual education, practicing active listening and collaborative negotiating skills, and building trust among the participants.

a. Full Group Meetings: LSSC members and resource experts met quite regularly, almost monthly at first, and less frequently as the work groups were created and became more active. Full group meetings were held in Green River, usually from 9 am to 3 pm, to equalize the travel load for everyone and to enable all participants to do the trip in one day. All full group meetings were facilitated by the EDR Program.

b. Work Groups: After enough trust had been established in the group to instill confidence that all perspectives would be considered as the details of issues were hashed out (about a year into the collaboration), and the necessary end products were agreed upon (e.g., monitoring plan, adaptive management plan), four work groups were established – the social/economic/administrative work group, the ecological work group, the grazing management work group, and the aquatic resources work group.

Each work group was made up of a subset of the LSSC members and resource experts as appropriate, designed to represent a cross-section of the stakeholder interests in the collaboration. The work groups were greatly assisted in their work by technical experts who had not been involved in the collaboration previously (Grazing Improvement Program scientists and the Southeastern Utah watershed coordinator).

These four work groups' discussions were coordinated by Trout Unlimited's representative on the LSSC. The discussions occurred via numerous conference calls, with draft work products revised and improved over email. The work groups' draft work products were then presented to all LSSC members and resource experts at full group meetings, with calls for consensus topic-by-topic and directions to the work group to continue discussions or make changes on topics where no consensus could yet be found. The work groups then renewed their efforts on those topics, and new proposals were brought back to the full group, until consensus was reached on each topic.

Towards the end of the LSSC's work, two more informal work groups came together to develop recommendations on (1) infrastructure and (2) adaptive implementation of the rotation schedule (i.e., how ecological integrity and functionality would be assessed in the future and how seasonal use would be determined for the purposes of "Real Time Adjustments" of the rotation schedule). The infrastructure work group was coordinated by the LSSC co-conveners; the adaptive management group was coordinated by TU's representative. They brought their recommendations to the full group for consensus-seeking discussion.

c. <u>Field Trips</u>: LSSC members and resource experts participated in two multiple-day field trips to observe on-the-ground conditions, and to explore potential solutions to difficult problems. Additional field trips were organized by work groups to confirm specific monitoring site locations. There were also many opportunities where individual LSSC members (especially the conservation interests and the producers) went into the field together to work through specific issues.

d. <u>Report Drafting</u>: The draft final report was a joint effort between the facilitator and the work group coordinator. The main text was drafted to reflect consensus agreements reached in full group meetings; the majority of the appendices were work group products which had also gone through the full group consensus process.

The first round of review and comments on the draft final report (via email) generated a good number of new issues, some of which were resolved through additional negotiations (in-person and via phone). Review of the second through fifth drafts of the final report generated extensive group discussion via conference calls and two additional all-day full group meetings. The sixth draft of the final report reflected all consensus recommendations, and was approved with minor edits. LSSC members and resource experts met on February 8, 2017, in Green River to sign the document and celebrate. The extended negotiations during the report-drafting process tested, and ultimately reinforced, the working relationships that had been established over the course of the 2-year collaboration.

II. RECOMMENDATIONS

Consensus recommendations to meet the goal of the LSSC follow. They are organized in three broad categories: Management Actions; Administrative Actions; and Assessing Progress/Accountability.

A. MANAGEMENT ACTIONS. Changes in management are recommended in several areas.

1. **Livestock Grazing**. LSSC recommendations on livestock grazing reflect a shared belief that changes in management can contribute to social, economic, administrative, and ecological sustainability.[1] Looking at the big picture, members recommend the producers' permits/authorizations be changed to support an approach to livestock grazing management that better distributes use and provides for greater variation in timing of that use across allotments and pastures. The recommendations are designed to use real-time conditions to affect grazing management. They also include long-term assessment and monitoring to measure the social, economic, and ecological results of management changes, and an adaptive management plan to ensure a systematic approach to adjusting operations as indicated.

   a. <u>Deferred Rotation Grazing System</u>: LSSC members recommend use of a deferred rotation grazing system to manage distribution, time, and timing of domestic livestock use of this landscape without changing currently permitted/authorized AUMs (Animal Unit Months). The recommended grazing system decreases the number of allotments from 7 to 4 and increases the number of pastures from 38 to 59 (**APPENDIX B**). This pasture reconfiguration -- along with changes in herding[2], thoughtful changes to points of entry into pastures, salting, and other practices that are detailed below -- are intended to enhance distribution of use, and increase variation in timing of use of pastures to promote ongoing plant productivity and resilience. The initial recommended allocation of time livestock spend in each pasture was based on historical use, an initial assessment of current ecological integrity and functionality, and presence of high value ecological and social resources (**APPENDIX C**). Sample rotation schedules are included in **APPENDIX D.** LSSC members recognize

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[1] Briske, 2001; Brunson & Burritt, 2009; Budd & Thorpe, 2009; Davies, 2014; Holechek et al., 1982; Laycock, 1994; Howery et al., 2004; Teague et al., 2009; Teague & Dowhower, 2003; Jones & Carter, 2016; Davies Kirk et al, 2016 .

[2] "Changes in herding" refers to practices such as increased focus on timely movement of livestock from one pasture to the next, and actively pushing cattle away from identified high value resources and areas.

that the dates of use in the sample rotation schedules will vary based on conditions on the ground.

b. Real-time Adjustment: Annual deferred rotation schedules should be implemented in adaptive fashion. Although these schedules are based on the best available information, there is much yet to be learned about how livestock will use the pastures – particularly given annual variation in timing of use, precipitation, and other factors. Therefore, guidelines (tied to the ecological integrity and functionality of each pasture) are provided for in-season modification of the rotation schedule (**APPENDIX E**). These guidelines are intended to inform adaptive management in support of sustainability goals, and will be revisited and adjusted as needed at the semi-annual LSSC meetings described in Section II.C.5.

c. Herd Composition: Each of the livestock producers has also made a commitment to replace 25% of their cow/calf pairs with yearling heifers on a one for one basis, meaning one heifer for each cow-calf pair. This change in herd composition is intended to:

- Make use of different parts of the landscape, reducing pressure on those historically used.
- Reduce forage requirements, trampling and other environmental impacts (i.e., 1 cow/calf pair grazed for a month = 1.3 animal unit months; 1 yearling heifer grazed for a month = 0.7 animal unit months).
- Provide greater flexibility and reduce economic risk to the producer in the face of drought, wildfire, or other factors limiting forage production.

d. Drought Strategy: Drought is a common visitor to the LSSC geography. Grazing livestock in this environment requires advance planning and proactive action to ensure social, economic, administrative, and ecological sustainability. Recommended principles and guidelines for preparing for drought and adjusting grazing management during and following drought are attached as **APPENDIX F**.

e. Infrastructure: Implementation of these grazing recommendations is partially dependent upon planning, constructing, and maintaining watering and gathering facilities, fences, cattle guards and other grazing infrastructure. **APPENDIX G** provides an initial listing of recommended grazing infrastructure, estimated costs, and potential funding sources. We expect additions of infrastructure will occur incrementally, providing an opportunity to evaluate the associated costs and benefits, which in turn will inform adjustments to the Appendix G list.

2. **Assessment and Monitoring:** The collaboration recommends assessment and monitoring efforts to provide accountability for progress toward Desired Conditions, including:

   a. Assessment of ecological condition by pasture. The Forest Service and BLM will assign an ecological integrity rating for each pasture of "High" "Moderate", or "Low" for the purposes of determining the extent of seasonal use (grazing and browsing) of grasses and palatable woody species that will inform the timing of movement of cattle from a given pasture. A preliminary assignment of ecological condition was undertaken by the permittees' consultant, with review and concurrence of several other members of the LSSC. (Appendix C, pp. C-1-4). New ratings will be assessed using *Interpreting Indicators of Rangeland Health* or *Describing Indicators of Rangeland Health* (Appendix E, Attachment 1). We recommend that these initial assessments be completed by the Forest Service and BLM in 2017.

   Subsequent assessments should occur when credible information suggests there may have been a change in ecological integrity and functionality.

   b. Annual monitoring of seasonal use in each pasture. Assessment of seasonal use of vegetation will largely be ocular (Appendix E, pp. 1-4). However, on a rotating basis, a utilization cage will be used for quantitative calibration of visual estimates of seasonal use at five high or moderate integrity pastures each year and annually in each low integrity pasture (Appendix E, p. 4). In addition the agencies and the producers' consultant will continue to collect measured end-of-season utilization data using their standard protocols.

   c. Monitoring of ecological indicators. Long term monitoring of ecological sustainability indicators will be undertaken at 22 key upland and 8 key riparian sites, and 8 streambank and aquatic sites to establish baseline conditions prior to implementation of recommended grazing modifications, three years later, and every five years thereafter. Various governmental and non-governmental entities have accepted responsibilities for particular quantitative measurements of native plant biodiversity, productivity; streambank and aquatic conditions; and other watershed conditions using specific protocols (Appendix I, Monitoring Plan, pp.I-10-44). Similar measurements will be undertaken inside seven 2-4 acre exclosures at seven key sites in order to help provide insight into the effects of grazing by domestic and wild ungulates, and the relative influence of climate/weather and other natural disturbance factors.

Where grazed area improvements at these key sites are not at least 65% of those within the cattle exclosures, a conversation will be triggered to understand why, and to determine if additional adjustments in management may be warranted. The field monitoring is open to observation by the public.

d. Monitoring of economic, social, and administrative indicators. Long term monitoring of economic, social and administrative indicators will also be completed. These indicators will be assessed at varying intervals according to specific protocols (Appendix I, Monitoring Plan, pp. I-10-15).

3. **Native Fish**. LSSC members are supportive of restoring the health, diversity, and productivity of native aquatic resources and provide for their use and resiliency in the face of climate change. Recommendations to support this vision include:

   a. Secure the functionality of watershed, riparian and instream processes.

   b. Protect and enhance, to the extent possible, the unique native cutthroat trout population in Beaver Creek.

   c. Re-introduce self-sustaining native cutthroat trout populations to Deer Springs Creek and La Sal Creek.

   c. Investigate the potential for protecting or re-introducing self-sustaining populations of native fish in:

      - Pack Creek and Upper Hell Canyon
      - Brumley Creek
      - Kane Creek

Effective re-establishment of native fish will require connecting fragmented steams where possible, constructing and maintaining barriers where appropriate, and removing non-native fish and reintroducing native species. Recognizing that the LSSC does not have authority with regard to ESA designation, in general the group does not expect native fish re-introductions to include species protected under provisions of the Endangered Species Act. Reintroduction of listed native fish may be supported if designated as “experimental, non-essential” populations.

Also, given the significance of the non-native brook trout to local anglers, conversion of the fishery and reintroduction of native cutthroat in La Sal Creek will be supported by the LSSC, if the following conditions are met:

During the period it takes to establish a native cutthroat population following removal of brook trout in La Sal Creek DWR will:

a. Stock catchable sterile rainbow and sterile fingerling brook or tiger trout in La Sal Creek. If sterile fish do not impede cutthroat trout establishment, the stocking of sterile trout may continue.

b. Continue to stock catchable sterile trout in Medicine Lake.

Critical actions to implement these recommendations by DWR include:

a. Validating the genetics of cutthroat trout in the streams of interest within the LSSC geography (i.e., collection of tissue samples in the fall of 2017, with completion of genetic analysis by spring of 2018).

b. Developing a hatchery brood stock to produce sufficient quantities of native cutthroat for reintroduction (3-5 years).

c. Planning for sufficient hatchery production of sterile trout and timing of availability to support a robust recreational fishery during and perhaps following establishment of self-sustaining populations of native cutthroat in La Sal Creek.

4. **Beaver**. LSSC members are committed to helping develop local support for beaver. Expansion of beaver is critical to increasing the extent of riparian areas, improving summer base flows, and enhancing the number and size of native trout within the LSSC geography. *Suitability* of streams for reintroduction of beaver should be determined using collaborative application of the Beaver Rapid Assessment Tool (BRAT)[1] in conjunction with affected interests and Utah State University. The BRAT model will help identify locations that will be ground-truthed by DWR biologists and interested partners. LSSC members recommend that this work be completed to support modification of the Utah Beaver Management Plan during the next revision cycle to allow for active management of beaver in additional *suitable* streams within the LSSC geography.

5. **Upland Forest Health**. Climate change and exclusion of fire from upland forests have contributed to an increased incidence of insects and disease, the potential for uncharacteristic wildfire, impaired watershed function, and reduced forage production. Therefore LSSC members recommend that the FS:

   a. Implement approved forest health restoration plans that restore fire to fire-adapted forests.

[1] Macfarlane W.W., Wheaton J.M., and Jensen, M.L. 2014. The Beaver Restoration Assessment Tool: A Decision Support and Planning Tool for Utah. Ecogeomorphology and Topographic Analysis Lab, Utah State University, Prepared for Utah Division of Wildlife Resources, Logan, Utah, 135 pp. Macfarlane WW , Wheaton JM**,** Bouwes N, Jensen M, Gilbert JT, Hough-Snee N, and Shivick J. 2015. Modeling the capacity of riverscapes to support beaver dams. Geomorphology. DOI: 10.1016/j.geomorph.2015.11.019

b. Expand forest health restoration planning efforts to incorporate additional areas – especially watersheds important to municipal water supply and/or native fish populations within the LSSC geography.

c. Involve and inform the LSSC of identified restoration needs.

The LSSC is committed to playing an ongoing supportive role in implementation of those plans.

6. **Wildfire**. Wildfire has historically been an important ecological process within the LSSC landscape (e.g., contributing to wildlife habitat diversity, nutrient recycling, forage production). Aggressive fire suppression, expansion of human development in the wildland interface, and climate change are contributing to larger, more severe wildfires. Uncharacteristic wildfires represent the most significant threat to conservation of native fish and favorable conditions of stream flow that support important recreational and agricultural uses in the area. However, allowing fire to play an increased role in managing conditions on the landscape is essential to reducing those threats.

   LSSC members recommend that the FS, BLM, and SITLA -- working through the Southeast Regional Catastrophic Wildfire Working Group -- complete an inter-agency, all lands/all funds, wildfire management plan for the La Sal Mountains and adjoining canyon lands within 5 years. Consistent with the 2013 *Utah Catastrophic Wildfire Reduction Strategy*[1] and 2014 *National Cohesive Wildland Fire Management Strategy*[2] the plan would:

   a. Identify high value resources and assets (HVRAs).

   b. Assess the risk wildfire may adversely impact those HVRAs.

   c. Delineate wildlands where restoration of resilience to wildfire is essential to sustaining critical ecosystem services (e.g., watershed health/water quality, quantity and timing; wildlife habitat) or where modification of vegetative conditions is needed to reduce threats to communities.

   d. Identify wildland-urban interface areas where modification of vegetative conditions and/or local zoning and building regulations are needed to reduce threats to communities.

   e. Delineate where and under what specific circumstances prescribed and natural wildfire may be used as a tool to meet management objectives.

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[1] https://www.ag.**utah**.gov/documents/Cat**Fire**FinalReport120213.pdf

[2] https://www.forestsandrangelands.gov/strategy/documents/strategy/CSPhaseIIINationalStrategyApr2014.pdf

f. Enhance coordination of agency/community investment in mitigation of risks to HVRAs from wildfire across jurisdictional boundaries.

Development of a wildfire management plan for this geography should provide for robust public engagement to promote the *social license* required to implement necessary changes in fire management and community resilience to wildfire. The LSSC is committed to playing an ongoing supportive role in development and implementation of those plans.

7. **Soil Erosion**. Protecting soil stability and productivity is essential to the social, economic, and ecological vibrancy, sustainability, and resiliency of the southern La Sal Mountains and adjoining canyon lands. Although it is expected that implementation of recommendations in this report will enhance soil conditions, LSSC members also recommend that within two years BLM, the FS, and SITLA, with stakeholder input:

   a. Identify and delineate important soil erosion issues.

   b. Establish goals to address those issues.

   c. Complete a plan to accomplish those goals.

   d. Inform the LSSC of identified restoration needs.

   The LSSC is committed to play an ongoing supportive role in accomplishment of those goals.

8. **High Value Areas**. Grazing of domestic livestock is a valid multiple use of state and federal lands within the LSSC geography – and occurs on nearly all areas of the landscape. During the course of the dialogue, shared interest in identifying areas where other multiple use values may benefit from exclusion of domestic grazing emerged. Members of the LSSC have identified two *High Value* areas from which we believe domestic livestock use could be excluded with little or no impact on the economic sustainability of the producers. **APPENDIX H** provides a description of those areas and outlines specific management recommendations to meet our shared desires for them.

9. **Social Conflicts**. Ensuring continued public support for domestic livestock use of public lands in the LSSC geography requires enhanced awareness of the benefits and timely resolution of social conflicts. Therefore members of the LSSC recommend:

   a. Development and implementation of an agreement to address conflicts in the Pack Creek residential area (e.g., fences, cattleguards) be given immediate priority.

   b. Design and placement of signs on gates to encourage all users to close gates to help keep livestock where they are intended to be.

c. Identification of key sites where fences should be moved or gates be replaced with cattleguards to eliminate conflicts with other users and placement of those cattleguards.

d. Design and placement of information about grazing on public lands at existing and new visitor facilities (e.g., visitor centers, kiosks, recreation areas).

The LSSC is committed to playing an ongoing supportive role in implementation of these recommendations.

B. ADMINISTRATIVE ACTIONS

1. **Operational Issues**. Full implementation of the grazing management recommendations requires that several operational issues be addressed through the administrative actions of the BLM and FS. LSSC members recommend:

   a. Elimination of the current gap between the dates of BLM grazing authorizations and FS grazing permits and provision for overlap in dates of those documents to facilitate proper use of the LSSC landscape given annual weather fluctuations and other factors (e.g., fire, grazing infrastructure project implementation).

   b. Timely permit/authorization transfer to facilitate management of two separate operations (i.e., La Sal Livestock and BLT Livestock). These transfers should be accomplished within FY 2017 (FS) and FY 2018 (BLM).

   c. Timely modification of grazing permits and authorizations that reflect consideration of LSSC recommendations contained in this report. Agency decisions on modifications should be accomplished within FY 2018 (FS) and FY 2019 (BLM).

2. **Regulatory Status of Cutthroat**. In 2009 the *Moab Times-Independent*[1] reported results of genetic analysis completed by Dr. Dennis Shiozawa of Brigham Young University (on behalf of the Utah Department of Wildlife Resources) suggesting the surprise discovery of Greenback Cutthroat Trout (GBCT) in Beaver Creek on the La Sal Mountains. This work post-dates recovery planning for GBCT led by the US Fish and Wildlife Service (FWS). A Recovery Plan was published in March 1998 and a Status Review for the trout was published in May 2009 -- which includes no mention of the La Sal population. It also post-dates recovery planning for Colorado River Cutthroat Trout (CRCT). A Conservation Strategy was published in June of 2006, which identifies several CRCT genetic management units – including one for the Dolores River which contains the Beaver Creek watershed.

[1] *Rare Trout Found in La Sal Mountains,* Ron Georg, contributing writer.

More recently, a study published in *Molecular Ecology*[1] makes the case that historically six lineages of cutthroat trout existed in the Southern Rocky Mountains – two of which went extinct in the early 20th century. Among the remaining lineages the authors assert that GBCT were historically limited to the South Platte River drainage, and today occur in only one stream (outside its historical range) – Bear Creek in the Arkansas River drainage. This finding is in sharp conflict with Recovery Plan conclusions that the recovery goal for GBCT is nearly met, and further heightens the conclusion in the status review that "...continued and refined genetic analysis, in conjunction with morphometric and meristic characteristics, may lead to proposed taxonomic changes for all cutthroat subspecies" and associated recommendation, i.e., "The Recovery Team, in coordination with the FWS, should make a determination of the taxonomic distinction between greenback and Colorado River cutthroat trout."

Subsequent discussion between LSSC members and those familiar with the more recent genetics analysis, suggest that Metcalf et. al were aware of and considered the results of genetic studies of the population in Beaver Creek in drawing their conclusion that GBCT are presently limited to a single stream in Colorado.

Although there appears to be mounting evidence that the native cutthroat in Beaver Creek are not GBCT, the FWS is bound to treat them as a listed species until their status is formally changed. This results in increased management costs and management uncertainties that work against support of expansion of native cutthroat trout populations within the LSSC geography.

Therefore LSSC members recommend:

a. Pressing the FWS and FS for prompt determination of the taxonomic distinction of GBCT and CRCT, to guide cutthroat reintroductions (see above management recommendations for Native Fish) and identification of the cutthroat lineage currently in Beaver Creek and appropriate regulatory changes.
b. Continuing to apply a precautionary approach to management of cutthroat trout in Beaver Creek – viewing them as a unique and potentially irreplaceable resource.

3. **Communication**. High quality communication within agencies, among agencies, and between the agencies, producers, and interested stakeholders is critical to the successful implementation of LSSC recommendations and accomplishment of

[1] *Historical Stocking Data and 19th Century DNA Reveal Human Induced Changes to Native Diversity and Distribution of Cutthroat Trout,* J.L. Metcalf et. al, Molecular Ecology (2012).

its goal for the social, economic, and ecological vibrancy, sustainability, and resiliency of the Southern La Sal Mountains and adjoining canyon lands.

To reduce the frequency and magnitude of “conflicts” and “surprises” within the LSSC geography that work against this goal, members of the LSSC recommend:

a. Documentation and dialogue, on an annual or semi-annual basis, of apparent “conflicts” and “surprises” resulting from inadequate intra-agency, inter-agency, and/or cross-stakeholder communication.
b. Identification of a process to promote continuity of effective working relationships in the face of relatively frequent changes in BLM, FS, and SITLA representation over time.

C. ASSESSING PROGRESS AND ACCOUNTABILITY. Members of the LSSC reached consensus on an approach for assessing progress toward its vibrancy, sustainability, and resiliency goal and promoting accountability for attainment of the goal. The five elements of that approach are described below.

1. **Desired Conditions and Indicators**. The LSSC recommends adoption of a system of specific *desired conditions* and *quantitative and qualitative indicators* against which progress toward its goal may be assessed.

    a. Desired Conditions. *Desired conditions* are a statement of what we are managing toward, or our objectives for conditions on the LSSC landscape. They are presented in terms of the social, economic, administrative, and ecological dimensions of that landscape.
    b. Quantitative Indicators. To evaluate progress toward each of the *desired conditions* and inform management changes we have sought to identify *quantitative indicators* that are most sensitive to management changes. These *quantitative indicators* will be periodically assessed at a network of monitoring sites across the LSSC landscape to provide trend information.
    c. Qualitative Indicators. Although *quantitative indicators* are essential to assessing progress and promoting accountability for attainment of *desired conditions* we recognize that in the harsh LSSC environment, measurable changes in vibrancy, sustainability, and resiliency due to management changes may only be conclusively detected over relatively long periods of time. Therefore we believe *qualitative indicators* also have an important role to play in adaptive management of this landscape. In this context, *qualitative indicators* include *any observable (but potentially difficult to measure) condition or situation* within the LSSC geography that may place attainment of the goal at risk.

APPENDIX I, **Table 1** (*Monitoring Plan*) summarizes the recommended desired conditions and indicators.

2. **Monitoring**. Q*uantitative indicators* will be periodically assessed at a network of 30 monitoring sites across the LSSC landscape to provide trend information. Methodology, location, timing, frequency and responsibility for collection and analysis of data are detailed in the recommended LSSC Monitoring Plan (**APPENDIX I**).

   At a subset of the monitoring locations (i.e., 7 sites) use of exclosures is recommended to help provide insight into:
   a. Ecological potential absent domestic livestock grazing.
   b. Ecological potential absent all ungulate grazing.
   c. Rates of change in ecological conditions with and without domestic or all-ungulate grazing.
   d. Relative influence of climate/weather versus the combination of climate/weather and grazing.

   Data will be collected, per the described methodology, at 23 monitoring sites and inside and outside the exclosures at 7 additional sites.

3. **Adaptive Management**. The LSSC is committed to co-discovering approaches to uses of the Southern La Sal Mountains and adjoining Canyonlands that are socially, economically, and ecologically sustainable. Although the consensus recommendations reflect the collective agreement to undertake the proposed grazing management approach using the best available science, we understand there is much yet to be learned and expect that adjustments will be needed over time to optimize outcomes in each of the three dimensions of sustainability. We are committed to continue to work together to identify and make changes in management that will enhance sustainability within the LSSC geography.

   An Adaptive Management Strategy (AM strategy) is recommended to promote accountability for, and successful attainment of our goal of vibrancy, sustainability, and resilience of the LSSC landscape (**APPENDIX J**). This AM strategy is intended to enable timely "course corrections" to management toward attainment of shared *desired conditions*, and outlines how we will continue to learn and apply that knowledge.

4. **Performance Rewards for Producers**. While initial gains in ecological integrity, functionality, productivity and resilience from the proposed management changes will primarily be targeted at ensuring ecological improvement and restoration, we expect near-term benefits to the producers in terms of:
   a. Decreased vulnerability to impacts of wildfire, drought, and legal and administrative challenges to their use of state and federal lands.

b. Improved condition of their livestock (e.g., weight gain, reproductive success).

As the ecological system improves to high integrity and functionality (as described in **Appendix E**) we are committed to and recommend sharing a portion of those dividends in terms of supporting additional use of currently permitted/authorized AUM's[1] as can be accomplished while providing for ecological vibrancy, sustainability, and resiliency.

5. **Ongoing Role of LSSC**. Members of the LSSC recognize full attainment of our goal and associated desired conditions will require additional work and a long-term commitment. We are committed to staying engaged in the evaluation, refinement, and implementation of our recommendations, and ongoing assessment and improvement of management of this landscape. Meetings of the LSSC will initially be convened semi-annually – in early December and mid-June of each year as detailed in the Monitoring Plan and Adaptive Management strategy (**APPENDICES I and J**). A sample agenda for those meetings is included as **APPENDIX K**.

III. LESSONS LEARNED

LSSC participants (consensus-seeking members, resource experts, facilitator) were invited to share their Lessons Learned about the collaborative process. The comments submitted are printed here without attribution, and edited solely for typos and grammar. They have been organized alphabetically (by first word), so no conclusions can or should be reached about which stakeholder interest said what.

- A rancher can wear a tank top, shorts and running shoes too.

- <u>Composition</u>. Who is at the table makes all the difference in the world. Having the right interests represented is important, but the success we enjoyed had everything to do with the characteristics of the participants themselves – both members and agency advisors. Critical personal characteristics include: transparency (*candid sharing of perspectives and underlying values/rationale*); integrity (*to their underlying values*); commitment (*to a shared vision and the process and work*); compassion (*rather than condemnation of personal shortcomings*); and curiosity and openness (*to understand and learn from the perspectives and experience of others*). Bumps along the way to consensus recommendations were tied to limited instances where these personal characteristics weren't demonstrated.

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[1] Additional AUM's are limited to reinstatement of suspended AUMs based on ecological conditions and trends.

The fact that members of the collaboration were highly competent in technical skill and knowledge across a broad spectrum of specialties was a real bonus. I can honestly say that I feel appreciation and affection for every member of the LSSC. I admire and respect each.

I also want to acknowledge the tremendous contributions of agency personnel to the success of the collaboration – specifically, line officers that made their personal participation a priority and provided their staff the time and resources to capably inform our dialogue. The respect showed the LSSC effort and value added by agency personnel has been exemplary – despite many competing demands for their time. The BLM and FS demonstrated superlative, game-changing leadership in their advisory role to the collaboration. They are "public servants" in the truest sense of the phrase – genuinely caring for the interests of their communities, while bringing a long-term perspective to the conversation. I'm proud of my "government."

<u>- Facilitation</u>. Having a skilled facilitator is essential to the success of a collaboration. The LSSC facilitator is the best I've ever worked with. She is an outstanding listener (often understanding meaning behind comments that are lost on me); is an even handed "honest broker" that respects all perspectives and doesn't take sides; knows how to build a "container" where there is mutual respect and trust among diverse participants; knows when to "push" and when to allow "gestation" of ideas; holds participants accountable for their behavior and commitments; and is well acquainted with the mine-field of collaboration and how to help the group avoid detonating explosives. More than a "facilitator," ours is a COACH who views every member of the collaboration as an important part of the same team, and works hard, not just at the meetings but between meetings, to help each person contribute to the common success of the team.

- I also found out that I still have a fairly steep learning curve.

- I could see the dynamics of the group change as members and those of us in advisory roles got to know one another better; there seemed to be more willingness to trust and to come to understandings as a group by the time the first of the Final Drafts was being rolled out. Within meetings that group recognized this too, and were able to joke and talk about it at meetings. I think it was important that the changes people saw in each other were recognized as they were.

- I have made new friends.

- I was disappointed at the curve ball thrown in at the last minute, but it is what it is. People are just people.

- I was pleasantly surprised that a group so diverse could come together with any kind of compromise, but we did find a lot of common ground.

- If you enter a collaboration with the genuine intent to seriously collaborate, you need to listen and compromise while advocating for your position.

- It is important to have clear guidelines from your organization on what can and cannot be on the table early in the process.

It is important to have clear guidelines from your organization on how much compromise, if any, they are willing to make on an issue early in the process.

<u>- Participation</u>. Consistent and active participation by members of a collaboration is critical to success. Mutual understanding "emerges" through conversation – sometimes over months of dialogue. When participants aren't part of that co-discovery process their level of understanding and commitment to the agreements reached is compromised. I was disappointed that one organization (that had much to contribute) couldn't commit the time to participate in a way that may have allowed them to support the consensus recommendations of the LSSC.

- Recipe for collaboration success: Take 8-15 very different personalities holding strong views and assumptions about "the other," and put in a room monthly to learn together about the landscape they love. Mix in a sprinkle of negotiating and collaborative problem-solving support as needed. Add field trips to witness conditions on-the-ground in person whenever discussions get stuck. Separate out the critical issues into work groups containing a cross-section of perspectives and expertise. Cook in work groups until the issues are boiled down and consensus recommendations emerge. Reintroduce work group consensus recommendations to full group slowly, allowing time for discussion (stirring the pot) and viewpoints to meld. Combine all consensus recommendations in one draft report, continuing to discuss as necessary for viewpoints to coalesce. If at any point the collaboration starts bubbling over, reduce heat and redo previous steps of the recipe until done. The test of "done" is when group energy shifts from double-checking each ingredient of the consensus recommendations to creating the menu for a celebratory meal together.

<u>- Representation</u>. Having organizations that make up the collaboration delegate authority to a person to represent them in the dialogue is an important element of "container" building that I had never thought about. Knowing the person at the table has authority to make decisions on

behalf of their organization is so important to building trust. Unfortunately, toward the end of the process, one organization appeared to undercut the authority they had delegated to their representative – causing tremendous angst and ill-feelings that had to be worked through, and left scars, if not open wounds in the fabric of trust that is required for a healthy collaborative effort. At this point, I have to remain open to the possibility they can prove their trustworthiness going forward – but that feels like a high bar at this point.

- Spending one-on-one time with individuals from the collaboration is just as important as meeting as a group. The understanding and trust built during these interactions goes a long way.

- The field trips that we took as a group were critical to keeping the group moving forward, both in terms of forming recommendations based on the landscape, but also in terms of developing and improving relationships with each other. It seems to be much easier to get to know someone when you are sitting next to them in the sun on the grass, rather than around a table in a meeting room.

- The members of the LSSC put an extraordinary amount of time into the Final Report and all the appendices and it shows. I think they should be extremely proud of what has been accomplished.

- The producers' commitment to the process was vital, especially at the end when things almost fell apart. He had faith that good would come of it, and I believe good has come of it already and should continue to into the future.

- Trust is the number 1 building block of collaboration. It takes a long time to build, and only one moment to destroy. Turnover in organization's representatives can affect trust – the new representative lacks any group institutional history, and different personalities or negotiating styles change the group dynamic. "Back tables" (organizations' decision-makers in the home office) can affect trust by not staying current with where the group's conversations are going, then trying to exercise a veto at the last minute. Reality taking place outside the collaboration can affect trust – e.g. elections or actions taken by an organization in related matters that cause other group members to question full commitment to the collaborative outcome. It is a testament to the LSSC members' dedication and good faith that even though each of these was a factor (turnover, "back tables" and a changing reality), and trust was regularly tested, they reached consensus recommendations that envision a long-term working relationship with each other.

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V. APPENDICES

A. LSSC Operating Protocols

B. Maps of Recommended Modification of Allotment and Pasture Boundaries

C. Assessment of Current Ecological Integrity and Functionality, and Presence of High Value Ecological and Social Resources by Pasture

D. Sample Deferred Rotation Schedule

E. Recommended Guidelines for Real-Time Adjustment of Grazing Duration

F. Recommended Drought Strategy

G. Recommended Infrastructure to Facilitate Socially, Economically, and Ecologically Sustainable Livestock Grazing on the LSSC Landscape

H. High Value Areas and Recommended Management

I. Recommended Monitoring Plan

J. Recommended Adaptive Management Strategy

K. Sample Agenda for Semi-annual Meetings of the LSSC

VI. LSSC MEMBERS' SIGNATURES

By their signature below, each LSSC Member Organization agrees to the Consensus Recommendations contained in the Final Report and Consensus Recommendations, and Appendices A-K (with attachments), commits to support the recommendations through accompanying agency decision-making processes, and commits to implement actions for which that member has been assigned responsibility herein.

Luis + Beverly Treviño aka: BLT by Steve Deeter — 2-8-17

BLT Cattle Company — Date

Name of Person Signing: Steve Deeter

Title: Range Consultant

[signature] — 2-8-17

Grand Canyon Trust — Date

Name of Person Signing: Travis Bruner

Title: Arizona Forests Program Manager

La Sal Livestock Ltd. by: J. Lowry Redd — 2-8-17

La Sal Livestock Company — Date

Name of Person Signing: J. Lowry Redd

Title: General Partner

James H. Keyes — 2-8-17

San Juan County — Date

Name of Person Signing: Jim Keyes

Title: San Juan County Lands Team

Harv Forsgren — 2/8/17

Trout Unlimited — Date

Name of Person Signing: Harv Forsgren

Title: Senior Advisor

Nathan Roberts — 2-8-17

UT Grazing Improvement Program — Date

Name of Person Signing: NATHAN ROBERTS

Title: GRAZING IMPROVEMENT coordinator

[signature] — 2/8/17

UT Division of Wildlife Resources — Date

Name of Person Signing: Chris Wood

Title: Regional Supervisor

VII. SIERRA CLUB SEPARATE STATEMENT IN LIEU OF SIGNATURE

Feb. 6, 2017

Dear La Sal Sustainable Collaboration members,

The Sierra Club Utah Chapter chose to participate in the La Sal Sustainable Collaboration with the hope that we could achieve a more sustainable grazing regimen on the participating allotments. Lowry Redd took a huge risk when he entered into the Collaboration. We thank him for his willingness to work with diverse interests including organizations such as the Sierra Club. In all my experience with the Collaboration was enlightening. In particular I enjoyed the field trips and the opportunity to get a little understanding of how others view the land.

Right now I am not certain about the Sierra Club's further formal participation. Much of the conclusion of the Collaboration is based on future work and future assessments of ecological integrity. At my age I an uncertain that I can continue to follow the efforts of the Collaboration to the degree the Sierra Club needs in order to be a continuing partner. If we can find a replacement and train the replacement in Sierra Club policy and procedures we may be able to continue.

The Collaboration began and continued at a time when my primary functions in the Sierra Club were focused on other issues. I was not always able to be as engaged as would have been desirable. Even if I remain active with the Sierra Club and wished to engage in the Collaboration this would continue to be a problem

In addition to the above concerns some of the conclusions of the Collaboration are problematic to the Sierra Club. In particular we have difficulty with some of the proposed infrastructure. The Sierra Club can support some needs for minor fencing changes, placing motorized vehicle cattle guards at fence lines on authorized motorized trails, protecting and rehabilitating springs, and others. But the Sierra Club generally would not be supportive of adding fences, piping water long distances from sources, and perhaps others. We thank the Collaboration for not proposing any vegetation treatments as part of the Collaboration.

One of our reasons for participating in collaborations on small scale projects such as a small set of allotments is seeking provisions that are widely applicable by the agencies across a broad region of their management areas. We do not think the infrastructure proposal meets that criteria. They would not be feasible across all or even many allotments in Utah because of the size of the investment. Even if it were possible we think such a wholesale modification of the landscape for a single commercial use would not be wise.

From our perspective we think of sustainability in using public resources in terms of ecological sustainability with economic sustainability perhaps developing out of that ecological sustainability. The beginning of the Sierra Club Grazing Policy begins, "The primary goal of this Sierra Club federal public lands grazing policy is to protect and restore native biodiversity and achieve functional and self-sustaining ecosystems." This is our guideline for looking at grazing management.

We also have a fundamental disagreement about the ecological conditions of the allotments. We do not have the extensive body of fieldwork and knowledge of ecological conditions that we would like to have. On one field trip to the Hatch Point area we visited a number of sites. At the Windwhistle Campground there was a disagreement on the condition of the vegetation. Some grazing proponents saw the area as decadent while we perceived it as in far better ecological condition than surrounding lands. In the charts prepared of the conditions on the various allotments and pastures many were listed as in good condition. Without extensive knowledge of actual conditions we would not be willing to assume that is the case. I could not draw that conclusion from many of the sites we visited over the two years of meetings.

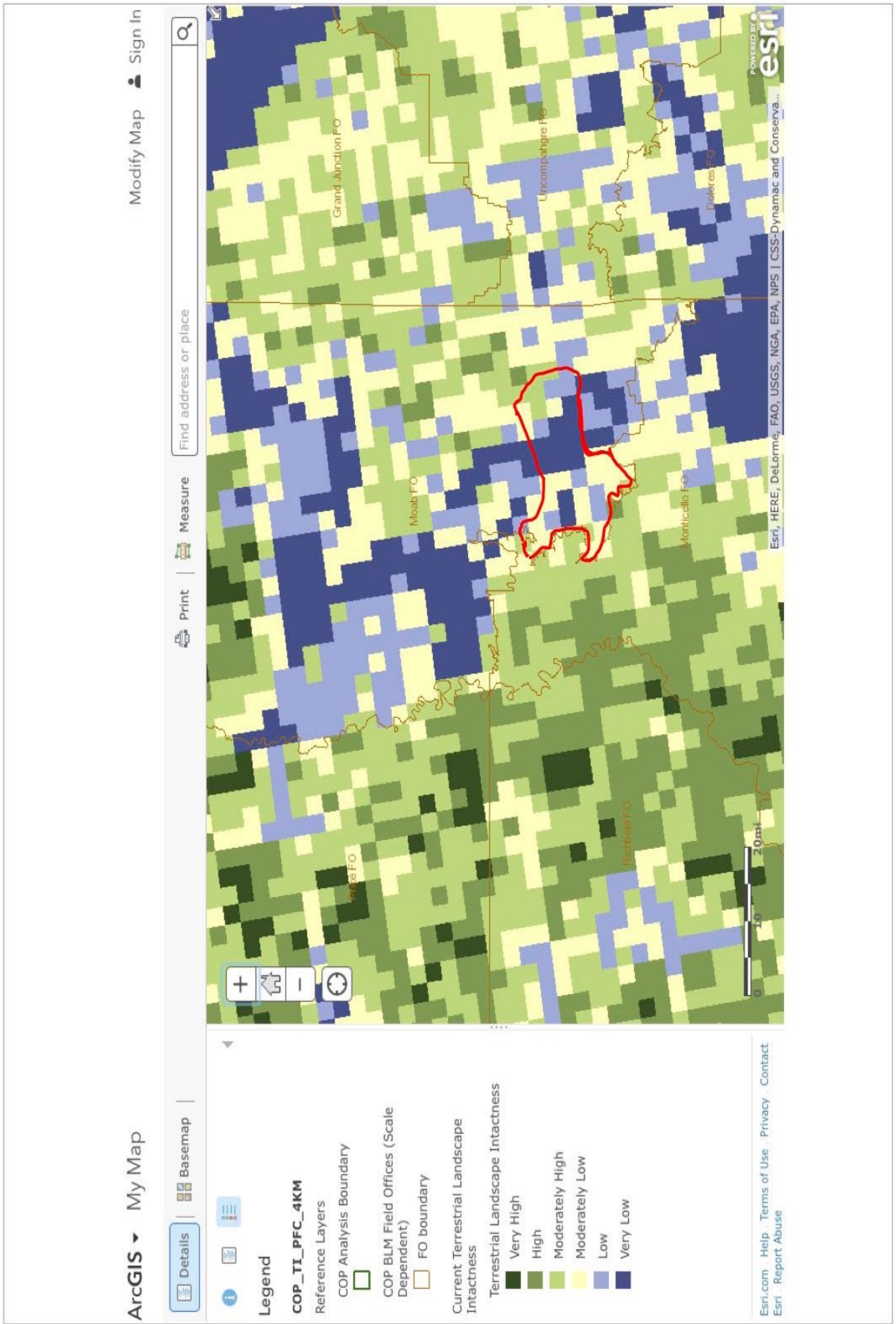
At the end of this letter I have inserted a Google Earth image derived from the BLM Colorado Plateau Rapid Ecosystem Assessment completed in 2012. I have hand drawn an outline of the La Sal allotments. It is approximate and not meant to be the exact boundaries just sufficient information to place them within the landscape. The map is a landscape assessment and not an acre by acre assessment. Never the less we think this is probably a fair representation of the ecosystem intactness of the area.

Following our experience with Tushar Collaboration we remain concerned about the Forest Service and Bureau of Land Management following through on Collaboration agreements.

There are a few other concerns I have about the some elements of the management proposed in the collaboration beyond those above. I will be curious about the results of the proposed management and particularly about any information that is or is not generated by the exclosures. I am particularly curious to see if the Collaboration results in on the ground improvements in the native biological communities.

Wayne Y. Hoskisson
Utah Chapter Sierra Club
PO Box 14
Moab, UT 84532

Terrestrial Landscape Intactness.pdf (2/2)



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La Sal Sustainability Collaboration

Operating Protocols
(Approved by Collaboration Members on Dec. 3, 2014)

I. Purpose

The purpose of the Collaboration is to co-create an approach to management of the area referred to as “Southern La Sal’s and Canyons” * where federal, state and private rangelands are operated as an integrated, sustainable system. The Collaboration’s recommendations will (1) provide for ecological resilience, (2) sustain economic viability, (3) promote cultural preservation, (4) be socially acceptable, and (5) be legally defensible.

* See reference map for area covered by this name

We recognize the importance of this difficult task, and choose to approach it as a collaborative effort, believing that input from a variety of government and private entities will ensure the best available resources and knowledge to work towards our shared goal of productive and resilient rangelands,[1] and strengthened relationships.

II. Approach

The Collaboration participants are working together to gain a better understanding of the various logistical concerns, interests, and perspectives at issue. With this enhanced understanding, the group will brainstorm creative solutions that best meet the needs of the various interest groups and the land in question.

The Collaboration will develop consensus recommendations for collaborative solutions, some of which will be presented for agency decision-making and some of which can be implemented independently.

III. Governing Structure

a. Name: La Sal Sustainability Collaboration (LSSC)

b. Participants

1. *Co-Sponsors*:

- Grazing Improvement Program (UT Department of Agriculture and Food)
- Grand Canyon Trust

[1] “Rangeland” is characterized by native plant communities that will provide the necessities of life for grazing and browsing animals, and is management by ecological, rather than agronomic, methods. Range resources are not limited to the grazable forage, but include wildlife, water, vegetative species diversity, and many other benefits. Grasslands, desert shrublands, savanna woodlands, forests, and tundra are the basic rangeland types of the world. [Definition adapted from two sources: (1) “Society for Range Management.” 2002. 29 Nov. 2014 http://www.rangelands.org/; (2) pg. 66 Holechek, Jerry L., Rex D. Pieper, and Carlton H. Herbel. “Range Management: Principles and Practices” (3rd Edition, 1997. Prentice Hall Professional Technical Reference.]

2. *Members*:

- La Sal Livestock Co. (Permittee) – representatives:
    - Lowry Redd
- BLT Cattle Co. (Permittee) – representative:
    - Steve Deeter
- San Juan County – representative:
    - Jim Keyes
- UT Grazing Improvement Program (GIP) – representative:
    - Slate Stewart
- UT Division of Wildlife Resources (DWR) – representative:
    - Chris Wood
- Conservation Groups
    - Grand Canyon Trust (represented by Dave Erley)
    - Trout Unlimited (represented by Harv Forsgren)
    - Sierra Club (represented by Wayne Hoskisson)

3. *Resource Experts*:

- US Forest Service (USFS)
    - Representative: Mike Diem
    - Alternate: Tina Marian
- Bureau of Land Management (BLM)
    - Representative: Lance Porter
    - Alternate: Kim Allison
- Natural Resources Conservation Service (NRCS)
    - Representative: Ammon Boswell
    - Alternate: Don Andrews
- School Institutional Trust Land Administration (SITLA) – representative:
    - Ron Torgerson
- San Juan Soil Conservation District
    - Charley Tracy
- US Fish & Wildlife Service (F&WS) – representative:
    - Paul Abate

4. *Facilitation Team*:

- Lead Facilitator: Michele Straube (Director, Environmental Dispute Resolution Program, S.J. Quinney College of Law, University of Utah)
- Assistant Facilitator: Meg Osswald (2016 JD Candidate, S.J. Quinney College of Law, University of Utah)

5. *Additions*:

To add additional LSSC members, there must be a consensus among the members that a particular interest is not already properly represented within the group.

c. Roles, Responsibilities, & Expectations

1. *Members*- All group members are expected to:
- Provide information in their particular area of expertise to the best of their abilities, including gathering outside information and meeting preparation when necessary.
- Listen to and participate in group discussion throughout the meetings.
- Ensure two-way communication with decision-makers in their own organization, and reflect the perspectives from their broader constituency as relevant, so that the Collaboration has full and accurate information and is aware of outside support and concerns.
- Bring any concerns about the group's work or the collaborative process to the Facilitation Team or Co-Sponsors.
- Follow the ground rules listed below in Section IV.
- Support and promote LSSC consensus recommendations.

2. *Facilitation Team*- The facilitator's role is to act as an impartial moderator between all participants to ensure that collaborative efforts are useful and meetings run smoothly. This will include developing meeting agendas, leading meetings, drafting meeting summaries, and additional communications outside of meetings as necessary.

Payment for facilitation services will be shared by the LSSC members. Payment will be made per meeting, with the particular member entity to be billed for each meeting determined on a meeting-by meeting basis. Facilitation Team costs will be assessed as follows: Ms. Straube's non-travel time will be billed at $125/hour, travel time at $50/hour, up to a maximum of $2,000/meeting (including preparation, in-meeting facilitation, meeting summaries, and between meeting coordination); Ms. Osswald's time is provided to the LSSC at no charge, as she is earning clinical course credit.

3. *Resource Experts*- Resource experts are encouraged to attend all LSSC meetings. They will serve as a technical resource to the collaborative process, but will not be official members.

d. Attendance

All group members agree to attend all meetings absent unforeseeable circumstances. If it is impossible to attend, absent members will be expected to give their input on the particular meeting topics in writing, rather than creating a situation in which those who attended the meeting need to repeat already discussed topics.

e. Alternates

Under special circumstances only, group members may be allowed temporary alternates to act on their behalf. Alternates must agree to follow the group's operating protocols. Alternates also agree to update the member they are temporarily replacing on developments that occur while the alternate is participating.

f. Compensation

Agencies or organizations will "sponsor" their representatives as Members and Resource Experts by covering all appropriate costs of participation.

g. Confidentiality
Participants will respect the proprietary nature of any information that other participants identify as confidential, and facilitators will not include this information in LSSC documentation. Facilitators will also consider private conversations with individual participants confidential unless otherwise stated.

h. Legal, Policy and Procedural Parameters
The collaboration process may inform compliance with, but is not subject to, federal legislation such as the National Environmental Policy Act (NEPA), the Federal Advisory Committee Act (FACA) or the Endangered Species Act (ESA).

Recommendations developed by the Collaboration do not constitute decision documents or federal actions that would require NEPA. Any federal action on those recommendations will follow applicable NEPA compliance processes, if required.

LSSC is exempt from FACA because: 1) the Collaboration is not convened by federal agencies; 2) although federal employees may provide information, none are members of the collaborative or "vote" on decisions made by the group; and 3) there is broad understanding that should federal agencies consider acting on recommendations of the Collaboration, they must do so in a manner that provides equal public access to their decision process.

The Collaboration has no authority to make decisions that affect threatened and/or endangered species that may occur in the area and its actions do not constitute either a formal or informal consultation process with the U.S. Fish and Wildlife Service. Therefore, provisions of the ESA do not apply.

i. Decision-Making Process
Decisions will be made by consensus whenever possible. The federal agencies and any other Resource Experts will not participate in the LSSC decision-making, but will advise on the substance and process to ensure that group recommendations are in-line with actual possible outcomes.

Consensus has been reached when everyone agrees to accept whatever is proposed after every effort has been made to meet the interests of all participants. Participants have the right to expect that no one will ask them to undermine their interests and share the responsibility to propose solutions that meet everyone else's interests as well as their own. If consensus cannot be reached, the group will consider the following steps:

- An additional site-tour to gain a better understanding of the issues;
- Individual(s) not in consensus will be given the opportunity to develop an alternative designed to meet everyone's interests; and
- Individual(s) not in consensus will be given the opportunity to educate or bring in additional informational resources.

As a last resort, the LSSC members can vote to move on and avoid holding up the process. This inability to reach consensus, along with the various alternatives under consideration, will be noted in writing and included in the recommendations sent to the agencies.

j. Quorum
For LSSC meetings to proceed, at least five of the eight LSSC members must be present, and at least one of the five present members must be a Permittee or their representative.

k. External Communication
Participants agree that if they speak to other people about the LSSC process, they will share accurate and objective information, relying on meeting summaries and other interim products for factual statements. Any and all opinions will be clearly identified as the speaker's own opinions, and due consideration will be given to the effect that an individual participant's comments may have on other participants and the process.

External communications on behalf of the group are authorized as follows:

- Unanticipated: Unanticipated requests for information about the LSSC process (e.g., from the media) will be responded to jointly by the co-sponsors.

- Anticipated: Any LSSC participant who wants to share information beyond publicly available facts about the LSSC process with external audiences should provide a draft to the group for review and input before publication. Requests for review and input received between meetings via email should include a reasonable response deadline.

l. Methodology / Scientific Accuracy
Participants will ensure professional and scientific integrity throughout the process. All final documents created will identify by footnote the methodology and sources relied upon for the conclusions and recommendations.

IV. Ground Rules- Group members agree to adhere to the following stipulations and to give other members the opportunity to:

- Act in good faith.
- Treat all group members with respect.
- Act professionally and courteously.
- Respect each other's perspectives and consider issues from other's point of view.
- Attempt to compromise to resolve differences.
- Brainstorm to find solutions that work for all group members.
- Openly explore all potential options in a safe, non-judgmental environment.
- Bring expertise and share with the group when beneficial.
- Maintain confidentiality.
- Disclose personal or employer interests, where a potential conflict of interest exists.
- Recognize and learn from the past, acknowledge the present, and envision together where we want to be in the future.
- Will not initiate or engage in activities related to but separate from the group that have the potential to undermine this group's success.
- Fairly and responsibly report group outcomes back to the participant's organizations.
- Ensure scientific integrity of discussions.

V. Logistics

a. Meeting Notes
The Facilitation Team will take the meeting notes and provide organized summaries of the meeting outcomes to LSSC participants for their reference no later than one week before the following meeting. Comments will only be attributed to individuals upon request. Any edits to meeting notes or outcomes will be made prior to, or during, the next scheduled meeting.

b. Meeting Structure
The facilitators will work with LSSC co-sponsors to develop meeting agendas. The Facilitation Team will run the meetings.

Meetings will be open to the public to attend, but meeting participation will be reserved for LSSC participants, unless visitors are invited to speak and participate by LSSC Members. Members of the public attending a LSSC meeting are welcome to submit written comments to the group. If the group finds that there is a greater need for public participation, a separate public meeting can be held.

c. Timeline
The LSSC aspires to complete its work within one year (by November 2015), but will revisit their progress at that time.

d. Scheduling
To the extent possible, meeting times will be scheduled several months in advance to enable members and Resource Experts to block out the necessary time. Participants are nevertheless expected to come prepared to select times for future meetings on the day of the current meeting.

VI. Desired Outcomes

a. Scope and Focus

The ultimate goal of the LSSC is to achieve consensus concerning the following items in relation to the Southern La Sal's and Canyons area:

- Desired conditions and objectives for landscape;
- Indicators to measure progress toward desired conditions;
- Long-term approach to implementation, with monitoring to evaluate desired outcomes;
- Grazing management plan (and associated regulatory approvals);
- Long-term range productivity and resilience;
- Desired species composition and productivity;
- Actions at specific sites to support the above; and
- Public education about all of the above.

b. Documentation / End Product(s)
LSSC will develop a final document containing consensus recommendations on the issues identified in the previous section, including any additional information required under Section III.i. The final document may be written and submitted to decision-making agencies in stages, if some implementable consensus recommendations are reached earlier than others.

As part of LSSC recommendations, the group will consider creating an ongoing group to review and provide input to land managers annually on resource conditions and management of the Southern La Sal's and Canyons area. If the recommendations suggest that an ongoing group is valuable, they will identify suggested membership and frequency of future meetings. Any ongoing groups will provide information to land managers for adaptive management purposes, without being a decision-making or advisory group.

LSSC will seek funding as a group to implement agency-approved recommendations.

VII. Revision of Operating Protocols

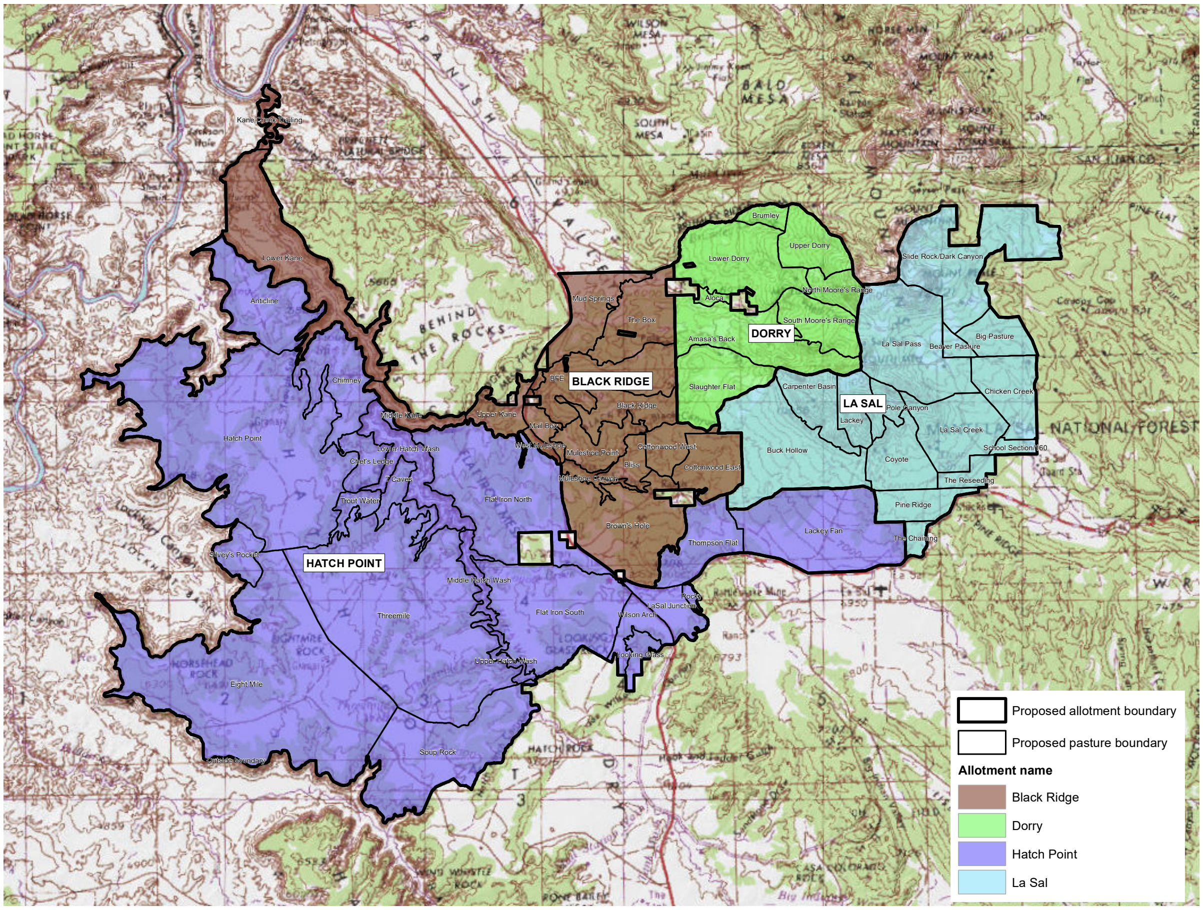
By consensus, LSSC members may add to or revise these operating protocols.

These Operating Protocols were approved unanimously by consensus of the LSSC Members at the December 3, 2014 meeting.

Appendix B: Recommended Modification of Allotment and Pasture Boundaries

CURRENT			**PROPOSED**	
Allotments:	**Pastures:**		**Allotments:**	**Pastures:**
Dorry - FS	Lower Dorry		Dorry - FS	Lower Dorry
	Upper Dorry			Upper Dorry
	Moores Range			North Moore's
	Amasa Back			South Moore's
	Slaughter Flat			Brumley
				Amasa Back
Black Ridge - BLM	Mud Springs			Slaughter Flat
	Black Ridge			Aloca
	Cottonwood			
Kane Springs - BLM	Upper Kane		Black Ridge - BLM	Mud Springs
	Lower Kane			Black Ridge
	Hatch Wash			Cottonwood East
				Cottonwood West
South Block - SITLA	Big Pasture			BFE
	Beaver Pond			The Box
	Slide Rock/Dark Canyon			Mail Box
	Geyser			Muleshoe Point
				Bliss
				Brown's Hole
La Sal - FS	La Sal Pass			Muleshoe Canyon
	La Sal Creek			West Muleshoe
	Coyote			Upper Kane
	Pine Ridge			Middle Kane
	Buck Hollow			Lower Kane
				Kane Creek Trailing
Private	The Chaining			
	160/School Section		La Sal - FS/SITLA	La Sal Pass
	The Reseeding			La Sal Creek
				Coyote
Chicken Creek - FS	Chicken Creek			Chicken Creek
				Buck Hollow

CURRENT			**PROPOSED**	
Allotments:	**Pastures:**		**Allotments:**	**Pastures:**
Hatch Point - BLM	Lackey Fan			Pine Ridge
	Thompson Flat			Carpenter Basin
	Brown's Hole			Lackey Basin
	Bliss			Pole Canyon
	La Sal Junction			Slide Rock/Dark Canyon/Guyzer
	Looking Glass			Big Pasture
	Flat Iron North			Beaver Pond
	Flat Iron South			
	Eight Mile		Private	The Reseeding
	Three Mile			The Chaining
	North Hatch Point			160/School Section
	Silvey's Pocket			
	Far North Hatch Point		Hatch Point - BLM	Lackey Fan
	Trout Water			Thompson Flat
8	**38**			Wilson Arch
				Soup Rock
				La Sal Junction
				Looking Glass
				Flat Iron North
				Flat Iron South
				Eight Mile
				Three Mile
				Hatch Point
				Silvey's Pocket
				Anticline
				Trout Water
				Chimney Rock
				Seven Caves
				Chet's Ledge
				Lower Hatch Wash
				Middle Hatch Wash
				Upper Hatch Wash
				Rocky Pasture
			5	**60**


HATCH POINT
BLACK RIDGE
DORRY
LA SAL
NATIONAL FOREST
Proposed allotment boundary
Proposed pasture boundary
Allotment name
Black Ridge
Dorry
Hatch Point
La Sal

Appendix C: Assessment of Initial Ecological Integrity and Functionality, and Presence of High Value Ecological and Social Resources by Pasture

La Sal Ecological Condition – Initial Assessment

Pasture Name	**Ecological Integrity & Functionality and Goal**	**High Value Resources Present**	**Relative Significance of Livestock Grazing**	**Potential Grazing Management Actions**	**Location**
8-Mile		NO		Soup Rock Fence	BLM
3-Mile		YES/Riparian area			BLM
Hatch Point		NO			BLM
North Flat Iron		NO		North/South Flat Iron Fence	BLM
South Flat Iron		NO			BLM
Trout Water Camp (Heifers)		NO			BLM
Chimney Rock		NO			BLM
7-Caves		NO			BLM
Silveys Pocket		NO			BLM
Anticline		NO			BLM
Thompson Flat		NO		Be a part of rest rotation with Lackey Fan.	BLM
Lackey Fan		NO		Be a part of a rest rotation between Thompson Flat	BLM
Buck Hollow		NO		Going to be used as deferred rotation with water and brush treatments	FS

Lackey/Carpenter/Pole		YES/Riparian Area		Water Development & light use with yearlings.	FS
Coyote		YES/Spring Source		Water improvements/treatments/ Veg Treatment on west end & use riders to keep cattle dispersed.	FS
La Sal Creek		YES/Riparian area		Use riders to disperse cattle. Tightening up management practices. Changing to Deferred will also help improve this.	FS
The Pass		YES/Spring Source, Native Fish		Will implement change of timing with defered rotation.	FS
Dark Canyon		YES/Spring Source			FS
Chicken Creek		YES/ High Fuel load, Riparian Area, Native Fish			FS
Pine Ridge		NO		PJ treatments. Apply a division fence. Will help powerline right away.	FS
The Big Pasture		NO			SITLA
Slide Rock		NO			SITLA
Beaver Pond Pasture		NO		Goat Treatment for Snow Bush.	SITLA

Key for Ecological Integrity and Functionality of Pastures

Ecological Integrity / Functionality and Goal:

High (Green) – Impairment of soil conditions and/or the composition and vigor of vegetation is negligible; or data is available to suggest that areas with limited impairment are on an upward trend. Goal – maintain high ecological integrity and functionality.

Medium (Yellow) – Impairment of soil conditions and/or the composition and vigor of vegetation is present, but limited and the trend is stable. Goal – improve ecological integrity and functionality.
Low (Red) – Impairment of soil conditions and/or the composition and vigor of vegetation exists to an extent that threatens long-term ecological sustainability, or is trending downward. Goal – restore ecological integrity and functionality.
Key for Relative Significance of Livestock Grazing:
High (Red) – Adjustment of livestock grazing would clearly improve ecological integrity and functionality.
Medium (Yellow) – Livestock grazing may be one of the factors affecting ecological integrity and functionality.
Low (Green) – Adjustment of livestock grazing is unlikely to affect ecological integrity and functionality.

BLT—Ecological Condition – Initial Assessment

Pasture Name	Ecological Integrity & Functionality and Goal	High Value Resources Present	Relative Significance of Livestock Grazing	Potential Grazing Management Actions	Location
Slaughter Flat		NO		Using True deferred rotation.	FS
Amasas Back		NO		Range improvements, Water Development	FS
Lower Dorry		NO		Water Development	FS
Upper Dorry		YES/Spring Source			FS
Brumley		YES/Riparian Area			FS
North Moore Range		NO			FS
South Moore Range		NO			FS
Watershed Exclosure		NO			FS

Cottonwood East		YES/Spring Source		Use Water & Fence to disperse and truly defer.	BLM
Cottonwood West		YES/Spring Source		Use Water & Fence to disperse and truly defer. Cattleguard & Fence.	BLM
Browns Hole		YES/Riparian Area			BLM
Black Ridge		NO			BLM
Bliss		YES/Spring Source		Needs to be fenced off and piped off.	BLM
Muleshoe Point		NO			BLM
Muleshoe Canyon		NO			BLM
West Muleshoe		NO			BLM
Mail Box		NO			BLM
Upper Kane		YES/Riparian Area			BLM
Middle Kane		YES/Riparian Area		Tamarisk Control	BLM
Lower Kane		YES/Riparian Area			BLM
Key for Ecological Integrity and Functionality of Pastures					
Ecological Integrity / Functionality and Goal:					
High (Green) – Impairment of soil conditions and/or the composition and vigor of vegetation is negligible; or data is available to suggest that areas with limited impairment are on an upward trend. Goal – maintain high ecological integrity and functionality.					
Medium (Yellow) – Impairment of soil conditions and/or the composition and vigor of vegetation is present, but limited and the trend is stable. Goal – improve ecological integrity and functionality.					
Low (Red) – Impairment of soil conditions and/or the composition and vigor of vegetation exists to an extent that threatens long-term ecological sustainability, or is trending downward. Goal – restore ecological integrity and functionality.					

Key for Relative Significance of Livestock Grazing:
High (Red) – Adjustment of livestock grazing would clearly improve ecological integrity and functionality.
Medium (Yellow) – Livestock grazing may be one of the factors affecting ecological integrity and functionality.
Low (Green) – Adjustment of livestock grazing is unlikely to affect ecological integrity and functionality.

Historical Use—All Pastures

ALLOTMENT:	PASTURE:	Acres:	Type of Use:	# of Years:	Time Estimated on Past AUMs:	Average Historic AUMs/ Year:	Average Days Used/ Year	Average # of Head/ Year	Approx. LBS/Acre on	Growing Season:	Sensible Season of Use:	Avoidances/Considerations:	RIPs Needed to Improve Distribution & Facilitate Proposals:
La Sal	Buck Hollow	6427.67	All	7		457.5	15.3	900	56.9	Apr. 1 - Jul. 15	Spring/Fall	Low Larkspur	Water (well, ponds)
	Coyote	2422.02	All	9		743.3	25.0	913	245.5	Apr. 15 - Sep. 30	Late Spring-Late Fall		Pipeline extension, pipe spring run-off to pond in Pole Canyon, change pasture line with Pine Ridge, change boundary for new Pole Canyon Pasture

	La Sal Creek	3525.94	All	11		766.2	26.2	852	173.8	May 1 - Sep. 20	Late Spring-Late Fall		Water to SE from Deer Springs, realign La Sal Pass/La Sal Creek fence, change boundary along Chicken Creek SE corner
	La Sal Pass	5982.2	All	12		866.8	29.5	896	115.9	Jun. 1 - Sep. 15	Summer-Early Fall		See La Sal Creek, Watershed fence maintenance
	Dark Canyon	2110.79	All	8		212.8	26.9	232	80.7	Jun. 1 - Sep. 15	Summer-Early Fall	Subdivision fences,	
	Pine Ridge	1669.06	All	3		114.8	4.3	818	55.0	Apr. 1 - Sep. 30	Spring/Fall		Realign pasture boundaries to take in part of Coyote, powerline easement, water needed for fall use
	Lackey	6934.67	Year lings	0		*	*	*	#VAL UE!	Jun. 1 - Sep. 15	Summer-Early Fall	Trailing,	Trail work, water development, new fencing

	Carpenter	2077.64	Year lings	0		*	*	*	#VAL UE!	Jun. 1 - Sep. 15	Summer-Early Fall	Trailing,	Trail work, water development, new fencing
	Pole Canyon	893.65	Year lings	0		*	*	*	#VAL UE!	Jun. 1 - Sep. 15	Summer-Early Fall	Trailing,	Trail work, water development, new fencing
	Chicken Creek	3549.43	All	13		358.1	12.5	1012	80.7	May 1 - Sep. 30	Late Spring-Late Fall	Wildlife cycles	Realign fence in SW corner (see La Sal Creek), become part of the deferred rotation, 74 AUMs, spring development, pond cleaning
Dorry	Slaughter Flat	3245.49	All	6		182.2	27.3	202	44.9	Apr. 1 - Jul. 15	Late Spring-Late Fall	Elk use,	Water development (Buck Hollow Well Pipeline, Four way well, cleaning ponds, springs)

	Amasa Back/Pack Creek	4586.8	All	8		85.9	13.9	207	15.0	Apr. 1 - Aug. 1	Late Spring-Late Fall	Elk use,	Extend pipeline onto BLM, use season of use to defer use on one or the other and adjust the time (Spring = shorter time using Pack Creek, Fall = longer using Amasa Back)
	Lower Dorry	4820.19	All	8		163.7	26.4	189	27.2	Apr. 1 - Aug. 1	Late Spring-Late Fall	Elk use, Campground	Pipeline extension to lower railings
	Upper Dorry	2057.33	All	9		229.7	35.2	217	89.3	May 1 - Sep. 1	Summer-Early Fall		Water after July 15th, boundary fencing between Buzz and here, spring development, Sals Cabin pipeline and tanks (pumping)
Same in Historic	North Moores	1107.29	All	11		380	60.0	205	274.5	Apr. 15 - Sep. 15	Summer-Mid Fall		Spring development

Actual Use	South Moores	1888.69	All	*		*	*	*	#VALUE!	May 1 - Sep. 15	Summer-Mid Fall	Watershed maintenance	Trough replacements
	Brumley	583.91	All	1		62.4	9.0	211	85.5	Apr. 1 - Aug. 1	Late Spring/ Fall		
	Aloca	251.17	All	NO		Data	Gathering/Trail Through Pasture		#VALUE	Apr. 1 - Sep. 1	Late Spring/Late Fall	Subdivision	Fence around Pack Creek private
Hatch Point	Anticline	4138.22	B, 1's& 2's	6		165.2	73.7	99	31.9	Mar. 1 - Oct. 15	Late Fall-Spring		Permanent water hauls, pipeline extension
	Silvey's Pocket	950.63	B, 1's& 2's	2		85.3	49.0	53	71.8	Mar. 1 - Oct. 15	Late Fall-Spring	Access for breaking ice	Water development for flexibility in season of use
	Chimney Rock		B, 1's& 2's	1		264.7	38.0	212	#DIV/0!	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments
	Seven Caves		B, 1's& 2's	1		369.1	53.0	212	#DIV/0!	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments
	Chet's Ledge		B, 1's& 2's			*	*	*	#VALUE!	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments
	Trout Water		B, 1's& 2's	1		131.4	80.0	50	#DIV/0!	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments

	Trespass	2045.46	B, 1's& 2's	6		159.4	29.2	242	62.3	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments, off-site water
	Hatch Point	19495.72	All	8		1722.3	56.1	935	70.7	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments (existing wells, storage tanks, pipelines)
	Eight Mile	20407.21	All	7		2345	76.7	1204	91.9	Mar. 1 - Oct. 15	Late Fall-Spring		Fencing to split off Soup Rock, water developments (existing wells, storage tanks, pipelines, ponds)
	Soup Rock	7001.11	All	*		*	*	*	#VALUE!	Mar. 1 - Oct. 15	Late Fall-Spring		Fencing to split off Eight Mile, water developments (existing wells, storage tanks, pipelines, ponds)

	Three Mile	19003.21	All	8		1306.5	43.1	1035	55.0	Mar. 1 - Oct. 15	Late Fall-Spring		Water development (well piped two ways, existing ponds, water haul stations, spring on Three Mile & Little Water private lands pumped out,), Goodman Trail worked over
	Flat Iron North	6743.06	All	6		363.3	55.2	235	43.1	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments (permanent water hauls with pipelines, bentonite ponds), gap fence across canyon bottom to replace brush fence

	Flat Iron South	8421.7	All	7		314	49.1	227	29.8	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments (permanent water hauls with pipelines, bentonite ponds), fence from subdivision to rim and hwy 191 to complete split of Middle and south Flat Iron
	Flat Iron Mesa	1475.02	All	*		*	*	*	#VALUE!	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments (permanent water hauls with pipelines, bentonite ponds), fence from subdivision to rim and Hwy 191 to complete split of Middle and south Flat Iron

	Wilson Arch	1378.15	All	1		46.1	6.0	234	26.8	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments (existing wells, storage tanks, pipelines), Hwy undershot at mile marker 102 on private land, brush treatment
	Thompson Flat	1905.15	All	1		286.8	9.0	970	120.4	Mar. 1 - Oct. 15	Mid Fall-Early Summer		
	Lackey Fan	1355.74	All	9		954.5	34.7	1503	563.2	Mar. 1 - Oct. 15	Mid Fall-Early Summer		
	Looking Glass	568.71	Hors es	3		338.5	38.0	251	476.2	Mar. 1 - Oct. 15	Late Fall-Spring		Water developments (existing spring development, water haul, storage tanks, pipelines)
Black Ridge	Mudd Springs	8769.07	All	7		214.8	35.3	368	19.6	Mar. 1 - Oct. 15	Mid Fall-Early Summer		

	Cotton wood East	2139.57	All	4*		537.9	20.5	1466	201.1	Mar. 1 - Oct. 15	Mid Fall-Early Summer		Reconfigure pasture boundaries to split current pasture
	Cotton wood West	1427.08	All	*		*	*	*	#VAL UE!	Mar. 1 - Oct. 15	Mid Fall-Early Summer		Reconfigure pasture boundaries to incorporate some of FS (Slaughter Flat)
	Black Ridge	2071.22	All	3		251.4	37.3	406	97.1	Mar. 1 - Oct. 15	Mid Fall-Early Summer		
	Mail Box	766	All	3		41.3	13.3	103	43.1	Mar. 1 - Oct. 15	Mid Fall-Early Summer		
	Bliss (Data includes Muleshoe point also)	928.3	All	2*		58.8	30.5	100	50.7	Mar. 1 - Oct. 15	Mid Fall-Early Summer		
	Muleshoe Point	1754.37	All	1		70.4	32.0	67	32.1	Mar. 1 - Oct. 15	Mid Fall-Early Summer		
	Browns Hole	6576.7	All	7		256.2	35.0	269	31.2	Mar. 1 - Oct. 15	Mid Fall-Early Summer		

	Muleshoe Canyon	504.69	All	*		*	*	*	#VALUE!	Mar. 1 - Oct. 15	Mid Fall-Early Summer		
Kane Springs	Upper Kane	1202.59	All	7		72.5	24.0	120	48.2	Feb. 15 - Oct. 15	Mid Fall-Spring		
	Middle Kane	969.25	All	3		65.9	28.7	64	54.4	Feb. 15 - Oct. 15	Mid Fall-Spring		
	Lower Kane	6995.57	All	9		224.9	88.8	95	25.7	Feb. 15 - Oct. 15	Mid Fall-Spring		
	West Muleshoe	242.87	All	*		*	*	*	#VALUE!	Feb. 15 - Oct. 15	Mid Fall-Spring		
	Upper Hatch Wash	1021.66	All	*		*		*	#VALUE!	Feb. 15 - Oct. 15	Mid Fall-Spring		
	Lower Hatch Wash	2703.71	All	*		*		*	#VALUE!	Feb. 15 - Oct. 15	Mid Fall-Spring		
	Kane Creek Trailing	552.77	All	*		*			#VALUE!	Feb. 15 - Oct. 15	Mid Fall-Spring		
Private	Chaining	469.02	All						0.0	Apr. 1 - Sep. 15	Mid Spring-Mid Summer/ late Fall		

	Reseeding	1209.18	All						0.0	Apr. 1 - Oct. 1	Mid Spring-Mid Summer/ late Fall		
	160/School Section		All						#DIV/ 0!	Apr. 1 - Oct. 1	Mid Spring-Mid Summer/ late Fall		
	Geyser	2299.84	All						0.0	Jun. 1 - Sep. 15	Summer-Fall		
SITLA	Buck Pasture		All						#DIV/ 0!	Jun. 1 - Sep. 15	Summer-Fall		
	Beaver Pond	414.08	All						0.0	Jun. 1 - Sep. 15	Summer-Fall		
	Big Pasture	1546.29	All						0.0	Jun. 1 - Sep. 15	Summer-Fall		
	Slide Rock	2044.63	All						0.0	Jun. 1 - Sep. 15	Summer-Fall		
	Horse Pasture								#DIV/ 0!	Jun. 1 - Sep. 15	Summer-Fall		
* Indicates that this data is part of another pasture's historical data because of a proposed split.													

Squaw Springs—HU

PASTURE NAME:	YEAR:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:		PASTURE NAME:	YEAR:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:
Lower Squaw	1998	6/2-7/5	34	221	246.8		**Slaughter Flats**	1999	5/22-6/20	30	215	211.9
	1999	Rest	0	0	0.0			2001	6/1-7/6	36	207	244.8
	2000	6/1-7/3	33	100	108.4			2004	6/1-6/25	25	232	190.5
	2004	7/16-8/10	26	232	198.2			2007	6/1-6/22	22	192	138.8
	2006	6/10-7/4	25	211	173.3			2009	6/2-6/29	28	182	167.4
	2007	Rest	0	0	0.0			2013	6/7-6/29	23	185	139.8
	2008	6/5-6/25	21	180	124.2		**Average:**	**6**		**27.3**	**202**	**182.2**
	2009	9/26-10/18	23	168	126.9							
	2012	6/2-7/10	39	210	269.1							
	2013	10/8-10/17	10	192	63.1		**Lower Brumley**	1999	6/24-7/2	9	211	62.4
Average:	**8**		**26.4**	**189**	**163.7**							
							Amasa Back /Pack Creek	2000	6/3-6/14	12	113	44.5
								2004	6/26-7/15	20	232	152.4
Upper Squaw	1998	7/6-8/1	27	219	194.3			2006	5/24-5/31	8	211	55.5
	1999	7/3-8/15	44	211	305.0			2006	6/1-6/9	9	211	62.4
	2000	6/26-7/3	8	113	29.7			2007	6/23-7/21	29	192	182.9
	2000	7/4-8/8	36	213	251.9			2008	10/7-10/15	9	175	51.7
	2004	8/11-8/20	10	232	76.2			2009	6/30-7/8	9	182	53.8
	2006	7/5-8/11	38	211	263.4			2012	10/11-10/18	8	193	50.7
	2007	Rest	0	0	0.0			2013	6/30-7/6	7	145	33.3

	2008	6/26-8/6	42	180	248.4		**Average:**	**8**		**13.9**	**207**	**85.9**
	2009	8/15-9/25	42	168	231.8							
	2012	7/11-8/22	43	210	296.6							
	2013	9/11-10/7	27	192	170.3							
Average:	**9**		**35.2**	**217**	**229.7**							
Moores Range	1998	8/2-9/22	52	217	370.7							
	1999	8/16-10/4	50	211	346.6							
	2000	6/15-6/25	11	113	40.8							
	2000	8/9-9/25	48	213	335.9							
	2001	7/7-10/5	91	207	618.8							
	2004	8/18-10/15	59	232	449.7							
	2006	8/12-10/5	55	211	381.2							
	2007	7/22-10/10	81	192	510.9							
	2008	8/7-10/6	61	178	356.7							
	2009	7/9-8/14	37	168	204.2							
	2012	8/23-10/10	49	193	310.7							
	2013	7/7-9/10	66	115	249.3							
Average:	**11**		**60.0**	**205**	**379.6**							

La Sal—HU

PASTURE NAME:	YEAR:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:		Horses:		PASTURE NAME:	YEAR:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:
Buck Hollow	1998	5/24-6/15	23	994	751.1		99=3		**La Sal Creek**	1998	7/11-8/15	36	992	1173.2
	2000	5/21-6/1	12	988	389.5		06=6			2000	6/21-8/1	42	989	1364.6
	2002	5/18-5/29	12	880	346.9		08=6			2001	6/10-6/26	17	954	532.8
	2004	5/20-6/15	27	885	785.0		09=4			2002	6/26-7/25	30	880	867.3
	2006	5/22-6/2	12	894	352.4		13=6			2004	7/11-8/10	31	885	901.3
	2008	5/26-6/6	12	882	347.7					2006	7/1-7/26	26	894	763.6
	2012	6/6-6/14	9	777	229.7					2007	6/26-7/27	32	912	958.7
Average:	**7**		**15.3**	**900**	**457.5**					2008	7/8-8/7	31	1000	1018.4
										2009	6/29-7/8	10	820	269.4
										2012	7/18-8/5	19	500	312.1
Coyote	1998	6/16-7/10	25	992	814.7					2012	6/28-6/30	3	250	24.6
	2000	6/2-6/20	19	988	616.7					2013	9/28-10/8	11	671	242.5
	2001	10/29-11/17	20	1290	847.6				**Average:**	**11**		**26.2**	**852**	**766.2**
	2002	5/30-6/25	27	880	780.6									
	2004	6/16-7/10	25	885	726.8									
	2006	6/3-6/30	27	894	793.0				**La Sal Pass**	1998	8/16-9/13	29	992	945.1
	2007	Rest	0	0	0.0					1999	9/22-10/18	27	935	829.3
	2008	6/7-7/7	31	882	898.2					2000	8/2-9/1	31	986	1004.1

	2012	6/15-7/17	33	777	842.3					2001	6/27-8/1	36	954	1128.3
	2013	10/9-10/26	18	625	369.6					2002	7/26-8/25	31	880	896.2
Average:	**9**		**25.0**	**913**	**743.3**					2004	8/11-9/7	28	885	814.1
										2006	7/27-8/24	29	894	851.7
										2007	7/28-8/28	32	912	958.7
Chicken Creek	1998	10/16-10/29	14	989	454.9					2008	8/8-8/29	22	1000	722.7
	1999	7/1-7/15	15	978	481.9					2009	10/1-10/31	31	790	804.5
	2000	10/25-10/28	4	1200	157.7					2011	9/30-10/28	29	769	732.6
	2001	10/13-10/20	8	1346	353.7					2012	8/6-9/3	29	750	714.5
	2002	10/22-10/28	7	135	31.0				**Average:**	**12**		**29.5**	**896**	**866.8**
	2004	10/15-10/28	14	885	407.0									
	2006	10/8-10/21	14	894	411.2									
	2007	10/11-10/18	8	895	235.2				**Dark Canyon**	1999	8/4-9/14	42	88	121.4
	2008	10/11-10/24	14	1000	459.9					2000	9/4-9/27	24	150	118.3
	2009	7/5-7/9	5	823	135.2					2001	8/25-9/20	27	125	110.9
	2009	7/10-7/20	11	991	358.1					2002	9/8-9/20	13	135	57.7
	2009	10/28-10/30	3	791	78.0					2004	9/8-10/5	28	150	138.0

	2011	7/9-7/22	14	799	367.5					2009	8/25-9/30	37	790	960.2
	2012	10/9-10/24	16	670	352.2					2011	9/15-9/29	15	200	98.6
	2013	6/30-7/14	15	755	372.0					2013	8/25-9/6	13	150	64.1
Average:	**13**		**12.5**	**1012**	**358.1**					2013	9/7-9/22	16	64	33.6
									Average:	**8**		**26.9**	**232**	**212.8**
Pine Ridge	2006	10/26-10/28	3	894	88.1									
	2009	6/14-6/18	5	820	134.7									
	2013	6/13-6/17	5	740	121.6									
Average:	**3**		**4.3**	**818**	**114.8**									

Hatch Point—HU

PASTURE NAME:	Permit Year:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:	Type:		PASTURE NAME:	YEAR:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:	Type:
Anticline	1999-00	11/29-2/28	92	75	226.7	Yearlings		**Chimney Rock**	2005	1/27-3/5	38	212	264.7	Heifers
	2000-01	11/18-12/8	21	194	133.8	Yearlings		**Average:**	**1**		**38**	**212**	**264.7**	
	2004-05	12/15-1/26	43	212	299.5	Heifers								
	2009-10	11/18-1/20	64	50	105.1	Bulls		**Trout Water**	2010	1/21-4/10	80	50	131.4	Bulls
	2010-11	12/7-4/22	137	31	139.5	Bulls		**Average:**	**1**		**80**	**50**	**131.4**	
	2011-12	12/7-2/29	85	31	86.6	Bulls								
Average:	**6**		**73.7**	**99**	**165.2**			**Seven Caves**	2005	3/6-4/27	53	212	369.1	Heifers
								Average:	**1**		**53**	**212**	**369.1**	
Triangle (Trespass)	1993-94	11/25-12/1	7	263	60.5	Heifers								
90% PL	1997-98	3/2-4/25	55	150	271.0	Heifers		**Muleshoe Point**	2011	11/18-12/19	32	67	70.4	2 yr. olds
	1998-99	12/17-1/5	20	264	173.5	Heifers		**Average:**	**1**		**32**	**67**	**70.4**	
	1998-99	4/7-5/1	25	55	45.2	Bulls								
	1999-00	4/5-4/17	13	76	32.5	Yearlings		**Three Mile**	1994-95	11/29-1/13	46	1050	1586.7	

	1999-00	4/18-5/10	23	151	114.1	Yearlings		90% PL	1997-98	4/4-5/10	37	944	1147.4	Cows
	2004-05	4/28-5/13	16	212	111.4	Heifers			1998-99	12/1-1/4	35	1024	1177.4	
	2010-11	11/23-12/8	16	282	148.2	Heifers			1999-00	3/29-5/8	41	1052	1417.0	Cows
Average:	**6**		**29.2**	**242**	**159.4**				2000-01	11/21-12/22	32	968	1017.6	Cows
									2009-10	3/13-5/5	54	925	1640.9	Cows
Eight Mile	1994-95	3/9-5/11	64	1050	2207.6				2010-11	11/28-12/1	4	814	107.0	Cows
90% PL	1997-98	2/1-4/3	62	945	1924.8	Cows			2010-11	12/2-1/14	45	820	1212.2	Cows
	1998-99	2/16-5/8	82	1024	2758.5				2011-12	3/28-5/17	51	684	1146.0	Cows
	1999-00	11/18-1/22	66	1053	2283.1	Cows		**Average:**	**8**		**43.1**	**1035**	**1306.5**	
	2009-10	11/23-1/16	55	932	1684.0	Cows								
	2010-11	3/15-5/9	57	817	1529.9	Cows		**Bliss**	2008-09	4/26-5/9	14	175	80.5	
	2010-11	5/10-5/20	11	714	258.0	Cows			2019-10	3/20-5/5	47	24	37.1	Yearlings
	2011-12	12/1-2/1	63	688	1423.9	Cows		**Average:**	**2**		**30.5**	**100**	**58.8**	
Average:	**7**		**76.7**	**1204**	**2345.0**									
								Nipples	1993-94	11/16-11/24	9	263	77.8	Heifers

Lackey Fan	1993-94	11/3-11/18	16	1044	548.8				1994-95	4/2-4/29	28	295	271.4	
90% PL	1994-95	11/3-11/28	26	1050	896.8				1997-98	12/5-1/8	35	234	269.1	Heifers
	1994-95	5/12-6/13	33	1050	1138.3				1999-00	11/28-12/29	32	284	298.6	1's & 2's
	1997-98	11/5-11/18	14	950	436.9	Cows			2008-09	4/15-4/25	11	175	63.2	
	1998-99	11/10-11/30	21	1025	707.1				2010-11	12/9-12/15	7	273	62.8	Heifers
	1998-99	5/9-5/14	6	965	190.2	Cows			2010-11	12/16-2/24	71	228	531.8	Heifers
	1998-99	5/15-6/10	27	1012	897.6	Cows/ Bulls			2011-12	12/20-2/9	52	128	218.7	1's & 2's
	1999-00	10/29-11/17	20	1006	661.0	Cows		**Average:**	**7**		**35.0**	**269**	**256.2**	
	2000-01	11/4-11/20	17	958	535.0	Cows?								
	2009-10	11/06-11/22	17	930	519.4	Cows		**Flat Iron North**	1993-94	2/22-4/16	54	261	463.0	Heifers
	2010-11	11/4-11/14	11	663	239.6	Cows			1994-95	12/21-2/10	52	295	503.9	
	2010-11	11/15-11/27	13	211	90.1	Cows			1997-98	3/2-4/10	40	234	307.5	Heifers
	2010-11	5/6-5/20	15	25	12.3	Bulls			1997-98	4/17-4/20	4	202	26.5	Heifers
	2010-11	5/21-5/26	6	547	107.8	Cows/ Bulls			1999-00	2/11-4/5	55	287	518.6	1's & 2's
	2010-11	5/27-6/15	20	689	452.7	Cows/ Bulls			1999-00	4/15-4/30	16	195	102.5	Heifers

	2011-12	11/10-11/30	21	688	474.6	Cows			2008-09	11/18-2/14	89	102	298.2	
	2011-12	5/18-6/15	29	716	682.1	Cows/ Bulls			2009-10	4/5-5/5	31	71	72.3	Cows
Average:	**9**		**34.7**	**1503**	**954.5**				2011-12	4/5-5/7	34	198	221.2	1's & 2's
								Average:	**7**		**53.6**	**264**	**359.1**	
Silvey's Pocket	1999-00	2/29-4/17	49	75	120.7	Yearlings								
	2011-12	3/1-4/18	49	31	49.9	Bulls		**Flat Iron South**	1993-94	12/1-1/19	50	263	432.0	Heifers
Average:	**2**		**49.0**	**53**	**85.3**			90% PL	1997-98	1/9-3/1	52	234	399.7	Heifers
									1998-99	1/6-2/2	28	263	241.9	
Wilson Arch	1998	4/11-4/16	6	234	46.1	Heifers			1999-00	12/30-2/10	43	284	401.2	1's & 2's
Average:	**1**		**6**	**234**	**46.1**				2000-01	11/15-1/10	57	143	267.8	
									2008-09	2/15-4/3	48	102	160.8	
Thompson Flat	1994	5/8-5/16	9	970	286.8				2008-09	4/4-4/14	11	175	63.2	
Average:	**1**		**9**	**970**	**286.8**				2011-12	2/10-4/4	55	128	231.3	1's & 2's
								Average:	**7**		**49.1**	**227**	**314.0**	
Looking Glass	1994-95	2/11-4/1	50	295	484.6									

	1998-99	2/3-3/29	55	262	473.4									
	1999-00	4/6-4/14	9	195	57.7	Heifers								
Average:	**3**		**38.0**	**251**	**338.5**									
Hatch Point	1994-95	1/14-3/8	54	1050	1862.7									
	1997-98	11/19-1/31	74	950	2309.5	Cows								
	1998-99	1/5-2/15	42	1024	1412.9									
	1999-00	1/23-3/28	66	1052	2280.9	Cows								
	2000-01	12/23-2/4	44	971	1403.5	Cows?								
	2009-10	1/17-3/12	55	931	1682.2	Cows								
	2010-11	1/15-3/14	59	820	1589.4	Cows								
	2011-12	2/2-3/27	55	685	1237.7	Cows								
Average:	**8**		**56.1**	**935**	**1722.3**									

Black Ridge—HU

PASTURE NAME:	PERMIT YEAR:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:	Type:		PASTURE NAME:	PERMIT YEAR:	SEASON OF USE:	DAYS USED:	HEAD:	AUMs:	Type:
Mudd Springs	1993-94	4/30-5/14	15	222	109.4			**Cottonwood - Thompson (HP)**	1998	5/11-5/25	15	992	488.8	Cows/ Bulls
	1993-94	5/15-6/1	18	233	137.8	?/Bulls			2000	5/9-5/22	14	1042	479.2	Cows/ Bulls
	1997-98	5/1-5/31	31	212	215.9	Heifers								
	1999-00	5/1-5/16	16	195	102.5	Heifers								
	1999-00	5/17-5/30	14	204	93.8	Heifers/ Bulls								
	2001-02	5/2-5/12	11	190	68.7	Heifers?								
	2001-02	5/13-5/31	19	200	124.8	Heifers?/ Bulls								
	2009-10	10/17-11/5	20	71	46.6	Cows								
	2009-10	5/6-5/13	8	212	55.7	Cows								

	2009-10	5/14-5/31	18	223	131.9	Cows/ Bulls								
	2010-11	5/10-5/14	5	100	16.4	Cows								
	2010-11	5/15-6/2	19	160	99.9									
	2011-12	10/20-11/17	29	141	134.3	Cows								
	2011-12	5/8-5/31	24	210	165.6	Cows/ Bulls								
Average:	**7**		**35.3**	**368**	**214.8**									
Cottonwood	1993-94	5/9-5/15	7	950	218.5	Cows?								
	1993-94	5/16-5/26	11	999	361.0	Cows?/ Bulls								
	2001-02	5/5-5/13	9	889	262.8	Cows?								
	2001-02	5/14-5/20	7	924	212.5	Cows?/ Bulls								
	2009-10	5/6-5/14	9	713	210.8	Cows								
	2009-10	5/15-6/1	18	732	432.9	Cows/ Bulls								
	2012-13	5/29-6/18	21	657	453.3	Cows/ Bulls								
Average:	**4**		**20.5**	**1466**	**537.9**									

Black Ridge	1994-95	4/30-5/14	15	222	109.4										
89% PL	1994-95	5/15-6/2	19	233	145.4	?/Bulls									
	1998-99	4/27-5/24	28	215	197.8										
	2008-09	5/10-6/2	24	181	142.7										
	2012-13	5/9-5/11	3	180	17.7	Cows									
	2012-13	5/12-6/3	23	187	141.3	Cows/ Bulls									
Average:	**3**		**37.3**	**406**	**251.4**										

Kane Springs—HU

PASTURE NAME:	**YEAR:**	**SEASON OF USE:**	**DAYS USED:**	**HEAD:**	**AUMs:**	**Type:**		**PASTURE NAME:**	**YEAR:**	**SEASON OF USE:**	**DAYS USED:**	**HEAD:**	**AUMs:**	**Type:**
Middle Kane	1997-98	3/20-3/29	10	47	15.4	Bulls		**Lower Kane**	1993-94	1/19-2/21	34	263	293.8	
	2011-12	2/25-4/3	39	73	93.5	Cows		**89% PL**	1997-98	11/15-3/20	126	47	194.5	Bulls
	2012-13	2/1-3/9	37	73	88.7	Heifers			1998-99	11/18-11/24	7	35	8.0	Bulls
Average:	**3**		**28.7**	**64**	**65.9**				1998-99	11/25-3/10	106	71	247.2	Bulls
									2000-01	11/29-1/15	48	50	78.8	Bulls?
Mail Box	1997-98	4/21-4/30	10	202	66.4	Heifers			2008-09	11/20-3/9	110	73	263.8	
	1998-99	3/11-3/29	19	71	44.3				2009-10	11/6-3/2	117	71	272.9	Cows
	2000-01	11/14-11/24	11	37	13.4	Bulls?			2010-11	12/19-2/28	72	105	248.4	Cows/ Yearlings
Average:	**3**		**13.3**	**103**	**41.3**				2011-12	11/18-2/24	100	74	243.1	Cows
									2012-13	11/14-1/31	79	67	173.9	Heifers
Kane *	1993-94	1/20-2/21	33	263	285.1	Heifers		**Average:**	**9**		**88.8**	**95**	**224.9**	

	1994-95	11/13-12/21	39	299	383.1									
	1999-00	11/4-12/21	48	43	67.8	Bulls		**Upper Kane**	1993-94	4/16-4/30	15	222	109.4	
	1999-00	12/22-4/2	103	63	213.2	Bulls			2000-01	11/25-11/28	4	50	6.6	Bulls?
	2004-05	11/8-3/30	143	35	164.4	Bulls			2008-09	3/10-4/3	25	73	60.0	
Average:	**4**		**91.5**	**176**	**278.4**				2009-10	3/3-4/4	33	71	77.0	Cows
									2010-11	12/16-12/18	3	105	10.3	Cows/ Yearlings
									2010-11	3/1-4/3	34	105	117.3	Cows/ Yearlings
									2011-12	4/4-4/21	18	73	43.2	Cows
									2012-13	11/1-11/13	13	67	28.6	Heifers
									2012-13	3/10-4/1	23	73	55.2	Heifers
								Average:	**7**		**24.0**	**120**	**72.5**	

Appendix D: Sample Pasture Rotation La Sal Livestock and BLT Cattle

La Sal Livestock Main—Sample

Year	Allotment:	Pasture:	Total Count:	Type:	On Date:	Off Date:	# of Days:	# of AUMs:	Agency:	Total AUM's:	Current Permitted AUM's:
1	**Hatch Point**	Lackey Fan	750	Cow/Calf	1-Nov	25-Nov.	25	616.0	BLM/FS		
		Flat Iron North	750	Cow/Calf	26-Nov.	15-Dec	20	492.8	BLM		
		Flat Iron South	750	Cow/Calf	16-Dec	18-Dec	3	73.9	BLM		
		Soup Rock	600	Cow/Calf	19-Dec	27-Jan.	40	788.4	BLM		
		Eight Mile	600	Cow/Calf	28-Jan.	13-Mar.	45	887.0	BLM		
		Hatch Point	600	Cow/Calf	14-Mar.	31-Mar.	18	354.8	BLM		
		Hatch Point	750	Cow/Calf	1-Apr.	12-Apr.	12	295.7	BLM		
		Three Mile	750	Cow/Calf	13-Apr.	6-May	24	591.3	BLM		
		Flat Iron South	789	Bulls/Cow/Calf	7-May	15-May	9	233.3	BLM		
		Lackey Fan	789	Bulls/Cow/Calf	16-May	31-May	16	414.7	BLM	**6148.3**	**11281**
	Rested Pastures	Thompson Flat									

1	**Private**	The Chaining	789	Bulls/Cow/Calf	1-Jun.	5-Jun.	5	129.6	Private		
	La Sal	Pine Ridge	764	Bulls/Cow/Calf	6-Jun.	19-Jun.	13	326.3	FS		
	Private	Reseeding	764	Bulls/Cow/Calf	20-Jun.	24-Jun.	5	125.5	Private		
		School Sec./160	764	Bulls/Cow/Calf	25-Jun.	27-Jun.	3	75.3	Private		
	La Sal	La Sal Creek	764	Bulls/Cow/Calf	28-Jun.	6-Jul.	9	225.9	FS		
		La Sal Creek	976	Bulls/Cow/Calf/Heifers	7-Jul.	9-Jul.	3	96.2	FS		
		Chicken Creek	976	Bulls/Cow/Calf/Heifers	10-Jul.	21-Jul.	12	384.8	FS		
		Big Pasture	976	Bulls/Cow/Calf/Heifers	22-Jul.	4-Aug.	14	448.9	SITLA		
		Slide Rock	976	Bulls/Cow/Calf/Heifers	5-Aug.	1-Sep.	28	897.8	SITLA/ Private/ FS		
		Beaver Pond	976	Bulls/Cow/Calf/Heifers	2-Sep.	5-Sep.	4	128.3	SITLA	**1474.9**	**1200**
		La Sal Pass	976	Bulls/Cow/Calf/Heifers	6-Sep.	26-Sep.	21	673.3	FS		
		La Sal Creek	976	Bulls/Cow/Calf/Heifers	27-Sep.	1-Oct.	5	160.3	FS		
		Coyote	976	Bulls/Cow/Calf/Heifers	2-Oct.	15-Oct.	14	448.9	FS		
		Buck Hollow	826	Bulls/Cow/Heifers	16-Oct.	5-Nov.	21	569.8	FS	**3073.5**	**3686**
		-									

2	**Hatch Point**	Thompson Flat	600	Cow/Calf	5-Nov.	11-Nov.	7	138.0	BLM		
		Three Mile	600	Cow/Calf	12-Nov.	10-Jan.	60	1182.7	BLM		
		Hatch Point	600	Cow/Calf	11-Jan.	1-Mar.	50	985.5	BLM		
		Eight Mile	600	Cow/Calf	2-Mar.	31-Mar.	30	591.3	BLM		
		Soup Rock	750	Cow/Calf	1-Apr.	21-Apr.	21	517.4	BLM		
		Flat Iron South	750	Cow/Calf	22-Apr.	25-Apr.	4	98.6	BLM		
		Flat Iron North	750	Cow/Calf	26-Apr.	5-May	10	246.4	BLM		
		Thompson Flat	764	Bulls/Cow/Calf	6-May	21-May	16	401.6	BLM	**5754.6**	**11281**
	Rested Pastures	Lackey Fan									
2	**La Sal**	Buck Hollow	764	Bulls/Cow/Calf	22-May	30-May	9	225.9	FS		
		Coyote	764	Bulls/Cow/Calf	31-May	13-Jun.	14	351.4	FS		
		La Sal Creek	764	Bulls/Cow/Calf	14-Jun.	27-Jun.	14	351.4	FS		
		La Sal Pass	764	Bulls/Cow/Calf	28-Jun.	15-Jul.	18	451.8	FS		
		La Sal Pass	976	Bulls/Cow/Calf/Heifers	16-Jul.	18-Jul.	3	96.2	FS		
		Slide Rock	976	Bulls/Cow/Calf/Heifers	19-Jul.	8-Aug.	21	673.3	SITLA		

		Beaver Pond	976	Bulls/Cow/Calf/Heifers	9-Aug.	11-Aug.	3	96.2	SITLA		
		Big Pasture	976	Bulls/Cow/Calf/Heifers	12-Aug.	1-Sep.	21	673.3	SITLA	**1442.8**	**1200**
		Chicken Creek	976	Bulls/Cow/Calf/Heifers	2-Sep.	11-Sep.	10	320.6	FS		
	Private	School Sec./160	976	Bulls/Cow/Calf/Heifers	12-Sep.	15-Sep.	4	128.3	Private		
	Private	The Reseeding	930	Cow/Calf/Heifers	16-Sep.	22-Sep.	7	213.9	Private		
	La Sal	Pine Ridge	930	Cow/Calf/Heifers	23-Sep.	8-Oct.	16	488.8	FS	**2502.0**	**3686**
	Rested Pastures	The Chaining									
3	**Hatch Point**	Lackey Fan	930	Cow/Calf/Heifers	9-Oct.	12-Nov.	35	1069.3	BLM		
		Soup Rock	600	Cow/Calf	13-Nov.	2-Dec.	20	394.2	BLM		
		Hatch Point	600	Cow/Calf	3-Dec.	5-Feb.	65	1281.2	BLM		
		Eight Mile	600	Cow/Calf	6-Feb.	12-Mar.	35	689.9	BLM		
		Three Mile	600	Cow/Calf	13-Mar.	13-Apr.	32	630.7	BLM		
		Three Mile	750	Cow/Calf	14-Apr.	16-Apr.	3	73.9	BLM		
		Flat Iron South	750	Cow/Calf	17-Apr.	6-May	20	492.8	BLM		
		Lackey Fan	789	Bulls/Cow/Calf	7-May	18-May	12	311.0	BLM	**6520.1**	**11281**

	Rested Pastures	Thompson Flat									
3	**La Sal**	Coyote	789	Bulls/Cow/Calf	19-May	28-May	10	259.2	FS		
	Private	The Reseeding	789	Bulls/Cow/Calf	29-May	31-May	3	77.8	Private		
		School Sec./160	789	Bulls/Cow/Calf	1-Jun.	2-Jun.	2	51.8	Private		
	La Sal	Chicken Creek	764	Bulls/Cow/Calf	3-Jun.	12-Jun.	10	251.0	FS		
		The Big Pasture	764	Bulls/Cow/Calf	13-Jun.	2-Jul.	20	502.0	SITLA		
		Beaver Pasture	764	Bulls/Cow/Calf	3-Jul.	5-Jul.	3	75.3	SITLA		
		La Sal Pass	976	Bulls/Cow/Calf/Heifers	6-Jul.	8-Aug.	34	1090.1	FS		
		Slide Rock/Geyser	976	Bulls/Cow/Calf/Heifers	9-Aug.	30-Aug.	22	705.4	SITLA		
		Beaver Pasture	976	Bulls/Cow/Calf/Heifers	31-Aug.	1-Sep.	2	64.1	SITLA	**1346.8**	**1200**
		La Sal Pass	976	Bulls/Cow/Calf/Heifers	2-Sep.	3-Sep.	2	64.1	FS		
		La Sal Creek	976	Bulls/Cow/Calf/Heifers	4-Sep.	23-Sep.	20	641.3	FS		
	Private	The Reseeding	976	Bulls/Cow/Calf/Heifers	24-Sep.	26-Sep.	3	96.2	Private		
	La Sal	Pine Ridge	930	Cow/Calf/Heifers	27-Sep.	1-Oct.	5	152.8	FS		
		Buck Hollow	930	Cow/Calf/Heifers	2-Oct.	25-Oct.	24	733.2	FS	**3407.6**	**3686**

BLT-Black Ridge-Dorry-Sample

Year:	Allotment:	Pasture:	Total Count:	Type:	On Date:	Off Date:	# of Days:	# of AUMs:	Total AUM's:	Current Permitted AUM's:
1	**Black Ridge**	Mud Springs	196	Cow/Calf/Heifers	1-Nov.	25-Nov.	25	161.0		
		Cottonwood West	156	Cow/Calf	26-Nov.	9-Jan.	45	230.6		
		Cottonwood East	156	Cow/Calf	10-Jan.	23-Feb.	45	230.6		
		Brown's Hole	156	Cow/Calf	24-Feb.	4-Apr.	40	205.0		
		Bliss	186	Cow/Calf/Heifers	5-Apr.	18-Apr.	14	85.5		
		Muleshoe Point	186	Cow/Calf/Heifers	19-Apr.	2-May	14	85.5		
		Black Ridge	186	Cow/Calf/Heifers	3-May	10-May	8	48.9		
		Black Ridge	197	Bulls/Cow/Calf/Heifers	11-May	23-May	13	84.1		
		The Box	197	Bulls/Cow/Calf/Heifers	24-May	2-Jun.	10	64.7	1196.0	
	Rested Pastures	BFE Mailbox								
				Kane Herd						
1	**Black Ridge**	Lower Kane	50	Heifers	26-Nov.	19-Jan.	60	98.6		

		Middle Kane	50	Heifers	20-Jan.	29-Jan.	10	16.4			
		Upper Kane	50	Heifers	30-Jan.	15-Mar.	50	82.1			
		West Muleshoe	50	Heifers	16-Mar.	20-Mar.	5	8.2			
		Muleshoe Canyon	50	Heifers	21-Mar.	4-Apr.	15	24.6	230.0		
									1426.0	**1225**	**Over 201 AUMs**[1]
1	**Dorry**	Lower Dorry	232	Bulls/Cow/Calf/Heifers	3-Jun.	7-Jul.	35	266.8			
		Upper Dorry	232	Bulls/Cow/Calf/Heifers	8-Jul.	1-Aug.	25	190.5			
		North Moore's	232	Bulls/Cow/Calf/Heifers	2-Aug.	22-Aug.	21	160.1			
		South Moore's	232	Bulls/Cow/Calf/Heifers	23-Aug.	11-Sep.	20	152.4			
		Amasa's Back (Pack Creek) & Aloca	232	Bulls/Cow/Calf/Heifers	12-Sep.	25-Sep.	14	106.7			
		Amasa's Back	196	Bulls/Cow/Calf/Heifers	2-Oct.	14-Oct.	13	83.7			

[1] Browns hole pasture, Bliss pasture, Muleshoe point pasture and muleshoe canyon pasture AUMS are not accounted for. They are currently under the Hatch Point allotment. These AUM's will be coming from the Hatch Point allotment. Approximately 450 AUMs will be coming from Hatch point when the AUM's are transferred to Black Ridge. Then we will not be over 201 AUMs.
We will apply for 130 suspended AUM's, and we will adjust our numbers to meet permitted AUM numbers.

		Slaughter Flat	196	Bulls/Cow/Calf/Heifers	15-Oct.	27-Oct.	13	83.7	**1043.9**	1379
2	**Black Ridge**	Black Ridge	196	Cow/Calf/Heifers	28-Oct.	1-Dec.	35	225.4		
		Cottonwood West	136	Cow/Calf	2-Dec.	15-Jan.	45	201.1		
		Cottonwood East	136	Cow/Calf	16-Jan.	30-Jan	15	67.0		
		Browns Hole	136	Cow/Calf	31-Jan.	18-Feb.	19	84.9		
		Bliss	196	Cow/Calf/Heifers	19-Feb.	8-Mar	19	122.3		
		Muleshoe Point	196	Cow/Calf/Heifers	9-Mar	23-Mar.	15	96.6		
		Mailbox	196	Cow/Calf/Heifers	24-Mar.	13-Apr.	21	135.2		
		Mud Springs	196	Cow/Calf/Heifers	14-Apr.	4-May	21	135.2		
		The Box	196	Cow/Calf/Heifers	5-May.	19-May	15	96.6		
		Cottonwood West	196	Cow/Calf/Heifers	20-May	24-May	5	32.2		
		Cottonwood West	221	Cow/Calf/Heifers	25-May	4-Jun.	11	79.9		
		Cottonwood West	232	Bulls/Cow/Calf/Heifers	15-May	4-Jun.	16	121.9	1398.3	

	Rested Pastures	BFE									
				Kane Herd							
2	**Black Ridge**	Upper Kane	50	Heifers	2-Dec.	1-Jan.	30	49.3			
		Middle Kane	50	Heifers	2-Jan	13-Jan	12	19.7			
		Lower Kane	50	Heifers	14-Jan	17-Feb	35	57.5			
		West Muleshoe	50	Heifers	18-Feb	22-Feb	5	8.2	134.7		
									1533.0	1225	**Over 308**[2]
2	**Dorry**	Slaughter Flat	232	Bulls/Cow/Calf/Heifers	31-May	9-Jun.	10.0	76.2			
		Amasa's Back	232	Bulls/Cow/Calf/Heifers	10-Jun.	23-Jun.	14.0	106.7			
		South Moore's Range	232	Bulls/Cow/Calf/Heifers	24-Jun.	14-Jul.	21.0	160.1			
		North Moores Range	232	Bulls/Cow/Calf/Heifers	15-Jul.	14-Aug.	30.0	228.6			
		Upper Dorry	232	Bulls/Cow/Calf/Heifers	15-Aug.	14-Sep.	30.0	228.6			

[2] Browns hole pasture, Bliss pasture, Muleshoe point pasture and muleshoe canyon pasture AUMS are not accounted for. They are currently under the Hatch Point allotment. These AUM's will be coming from the Hatch Point allotment. Approximately 450 AUMs will be coming from Hatch point when the AUM's are transferred to Black Ridge. Then we will not be over 308 AUMs.
We will apply for 130 suspended AUM's, and we will adjust our numbers to meet permitted AUM numbers.

		Lower Dorry	232	Bulls/Cow/Calf/Heifers	15-Sep.	15-Oct.	31.0	236.3	**1036.5**	1379
3	**Black Ridge**	Mud Springs	136	Cow/Calf	16-Oct.	23-Oct.	7.0	31.3		
		The Box	136	Cow/Calf	24-Oct.	13-Nov.	21.0	93.8		
		BFE	136	Cow/Calf	14-Nov.	20-Nov.	7.0	31.3		
		Muleshoe Point	136	Cow/Calf	21-Nov.	10-Dec.	20.0	89.4		
		Bliss	136	Cow/Calf	11-Dec.	20-Dec.	10.0	44.7		
		Brown's Hole	136	Cow/Calf	21-Dec.	29-Jan.	40.0	178.7		
		Cottonwood East	196	Cow/Calf/Heifers	30-Jan.	15-Mar	45.0	289.8		
		Cottonwood West	196	Cow/Calf/Heifers	16-Mar.	14-Apr.	30.0	193.2		
		Black Ridge	196	Cow/Calf/Heifers	15-Apr..	9-May	25.0	160.9724047		
		Mailbox	196	Cow/Calf/Heifers	10-May	19-May	10.0	64.4		
		Mud Springs	232	Bulls/Cow/Calf/Heifers	20-May	29-May	10.0	76.2	1253.6	
3	**Black Ridge**	Lower Kane	50	Heifers	24-Oct	22-Dec	60.0	98.6		

		Middle Kane	50	Heifers	23-Dec	27-Dec	5.0	8.2			
		Upper Kane	50	Heifers	28-Dec	21-Jan	25.0	41.1			
		West Muleshoe	50	Heifers	22-Jan	26-Jan	5.0	8.2			
		Muleshoe Canyon	50	Heifers	27-Jan	16-Feb	21.0	34.5	190.5		
									1444.2	1225	**Over 219[3]**
3	**Dorry**	Lower Dorry	232	Bulls/Cow/Calf/Heifers	30-May	30-Jun	32.0	243.9			
		Upper Dorry	232	Bulls/Cow/Calf/Heifers	1-Jul	29-Jul	30.0	228.6			
		North Moore's	232	Bulls/Cow/Calf/Heifers	30-Jul	28-Aug	30.0	228.6			
		South Moore's	232	Bulls/Cow/Calf/Heifers	29-Aug	27-Sep	30.0	228.6			
		Amasa's Back (Pack Creek)	232	Bulls/Cow/Calf/Heifers	28-Sep	5-Oct	7.0	53.4			
		Slaughter Flat	196	Cow/Calf/Heifers	6-Oct-16	20-Oct	15.0	96.6			
									1079.8	1379	

[3] Browns hole pasture, Bliss pasture, Muleshoe point pasture and muleshoe canyon pasture AUMS are not accounted for. They are currently under the Hatch Point allotment. These AUM's will be coming from the Hatch Point allotment. Approximately 450 AUMs will be coming from Hatch point when the AUM's are transferred to Black Ridge. Then we will not be over 219 AUMs.
We will apply for 130 suspended AUM's, and we will adjust our numbers to meet permitted AUM numbers.

La Sal Livestock Bulls-Sample

Year:	Allotment:	Pasture:	Total Count:	Type:	On Date:	Off Date:	# of Days:	# of AUMs:	Agency:	Total AUM's:	Current Permitted AUM's:
1	**Hatch Point**	Wilson Arch	45	Bulls	16-Nov.	5-Dec.	20	29.6	BLM		
		Upper Hatch Wash	45		6-Dec.	10-Dec.	5	7.4	BLM		
		Middle Hatch Wash	45		11-Dec.	14-Jan.	35	51.7	BLM		
		Lower Hatch Wash	45		15-Jan.	5-Mar.	50	73.9	BLM		
		Upper Hatch Wash	45		6-Mar.	8-Mar.	3	4.4	BLM		
		La Sal Junction	45		9-Mar.	28-Mar.	20	29.6	BLM		
		Rocky Pasture	45		29-Mar.	31-Mar.	3	4.4	BLM	201.1	
		Home to Feedlot for Testing - 45 hd.			1-Apr.	7-May. Join main herd					
2	**Hatch Point**	The Rocky Pasture	45	Bulls	16-Nov.	20-Nov.	5	7.4	BLM		
		La Sal Junction	45		21-Nov.	25-Dec.	35	51.7	BLM		
		Upper Hatch Wash	45		26-Dec.	28-Dec.	3	4.4	BLM		

		Middle Hatch Wash	45		29-Dec.	22-Jan.	25	37.0	BLM		
		Lower Hatch Wash	45		23-Jan.	8-Mar..	45	66.5	BLM		
		Upper Hatch Wash	45		9-Mar.	12-Mar.	4	5.9	BLM		
		Wilson Arch	45		13-Mar.	31-Mar.	19	28.1	BLM	201.1	
		Home to Feedlot for Testing - 45 hd.			1-Apr.	See Herd Rotations Year 2					

3	**Hatch Point**	La Sal Junction	45	Bulls	1-Nov.	30-Dec.	60	88.7	BLM		
		Wilson Arch	45		31-Dec.	23-Feb.	24	35.5	BLM		
		Upper Hatch Wash	45		24-Feb.	25-Feb.	2	3.0	BLM		
		Middle Hatch Wash	45		26-Feb.	7-Mar.	10	14.8	BLM		
		Lower Hatch Wash	45		8-Mar.	21-Mar.	14	20.7	BLM		
		Upper Hatch Wash	45		22-Mar.	24-Mar.	3	4.4	BLM		
		Rocky Pasture	45		25-Mar.	27-Mar.	3	4.4	BLM	171.5	
		The Chaining	45		28-Mar.	10-Apr.	14	20.7	BLM		
		Home to Feedlot for Testing - 45 hd.			11-Apr.	7-May. Join main herd					

La Sal Livestock Heifers-Sample

Year:	Allotment:	Pasture:	Total Count:	Type:	On Date:	Off Date:	# of Days:	# of AUMs:	Agency:	Total AUM's:	Current Permitted AUM's:
1	**Hatch Point**	Three Mile	150	2 year olds	18-Dec.	19-Dec.	2	9.9	BLM		
		Hatch Point	355	Yearlings/2 year olds	20-Dec.	21-Dec.	2	23.3	BLM		
		Anticline	355	Yearlings/2 year olds	22-Dec.	15-Jan.	25	291.6	BLM		
		Chimney Rock	355	Yearlings/2 year olds	16-Jan.	4-Feb.	20	233.2	BLM		
		Chet's Ledge	355	Yearlings/2 year olds	5-Feb.	24-Feb.	20	233.2	BLM		
		Trout Water	355	Yearlings/2 year olds	25-Feb.	7-Mar.	11	128.3	BLM		
		Seven Caves	355	Yearlings/2 year olds	8-Mar.	17-Mar.	10	116.6	BLM		
		Silvey's Pocket	355	Yearlings/2 year olds	18-Mar.	31-Mar.	14	163.3	BLM	1199.4	
		Yearlings shipped home to feedlot for conditioning, 1st calf heifers join main herd.									
	La Sal	Carpenter Basin	212	Yearlings/Bulls	10-Jun.	20-Jun.	11	76.6	FS		
		Lackey Basin	212	Yearlings/Bulls	21-Jun.	29-Jun.	9	62.7	FS		
		Pole Canyon	212	Yearlings/Bulls	30-Jun.	6-Jul.	7	48.8	FS	188.0	

		Yearlings Join Main Herd 7-Jul.									
		The Chaining	150	2 year olds	16-Oct.	11-Nov.	27	133.0	Private		

2	**Hatch Point**	Three Mile	150	2 year olds	12-Nov.	13-Nov.	2	9.9	BLM		
		Hatch Point	150	2 year olds	14-Nov.	15-Nov.	2	9.9	BLM		
		Chet's Ledge	150	2 year olds	16-Nov.	15-Dec.	30	147.8	BLM		
		Trout Water	355	Yearlings/2 Year Olds	16-Dec.	31-Dec.	16	186.6	BLM		
		Seven Caves	355	Yearlings/2 Year Olds	1-Jan.	21-Jan.	21	244.9	BLM		
		Silvey's Pocket	355	Yearlings/2 Year Olds	22-Jan.	14-Feb.	24	279.9	BLM		
		Anticline	355	Yearlings/2 Year Olds	15-Feb.	9-Mar.	23	268.2	BLM		
		Chimney Rock	355	Yearlings/2 Year Olds	10-Mar.	31-Mar.	21	244.9	BLM	1392.1	
		205 Yearlings shipped home to feedlot for conditioning. 150-1st Calf to main herd.									
	La Sal	Lackey Basin	212	Yearlings/Bulls	15-Jun.	23-Jun.	9	62.7	FS		
		Pole Canyon	212	Yearlings/Bulls	24-Jun.	2-Jul.	9	62.7	FS		

		Carpenter Basin	212	Yearlings/Bulls	3-Jul.	15-Jul.	13	90.5	FS	215.9	
		Join Main Herd 16-Jul.									
3	Hatch Point	Flat Iron North	150	2 year Olds	13-Nov.	14-Dec.	32	157.7	BLM		
		Flat Iron North	355	Yearlings/2 Year Olds	15-Dec.	1-Jan.	18	209.9	BLM		
		Seven Caves	355	Yearlings/2 Year Olds	2-Jan.	16-Jan.	15	174.9	BLM		
		Trout Water	355	Yearlings/2 Year Olds	17-Jan.	31-Jan.	15	174.9	BLM		
		Silvey's Pocket	355	Yearlings/2 Year Olds	1-Feb.	18-Feb.	18	209.9	BLM		
		Anticline	355	Yearlings/2 Year Olds	19-Feb.	8-Mar.	18	209.9	BLM		
		Chimney Rock	355	Yearlings/2 Year Olds	9-Mar.	19-Mar.	11	128.3	BLM		
		Chet's Ledge	355	Yearlings/2 Year Olds	20-Mar.	31-Mar.	12	139.9	BLM	1405.6	
		205 Yearlings shipped home to feedlot for conditioning. 150-1st Calf to main herd.									
	La Sal	Pole Canyon	212	Yearlings/Bulls	15-Jun.	22-Jun.	8	55.7	FS		
		Carpenter Basin	212	Yearlings/Bulls	23-Jun.	5-Jul.	13	90.5	FS		

Lackey Basin	212	Yearlings/Bulls	6-Jul.	15-Jul.	10	69.6	FS	215.9	
Join Main Herd 16-Jul.									

Appendix E: Real-Time Adjustment of Grazing Duration by Pasture.

The La Sal Sustainability Collaboration (LSSC) recognizes the need to implement the recommended deferred rotation grazing system in adaptive fashion. Although appropriate grazing duration will be estimated before cattle enter a particular pasture, LSSC members propose use of observable indicators to guide timing of livestock movement by livestock managers from one pasture to the next to help ensure that sustainability goals will be accomplished. The indicators include seasonal use of key species (tied to ecological integrity and functionality by pasture), livestock behavior, and precipitation events near the end of the planned duration.

Seasonal Use of Key Species

Seasonal use of key species will be visually estimated using landscape appearance descriptors[1] to inform the duration of livestock grazing in each pasture. Key species will primarily be evaluated periodically by the producers' riders and/or range consultant while the pasture is being grazed. Others (e.g., agency personnel, other LSSC members) are encouraged to share seasonal use observations with the producers to ensure that livestock movement occurs promptly to meet the maximum desired levels of use.

Examiners making these estimates will focus on identified key areas within the pastures. Estimates are only as good as the training and experience of the examiners. Training akin to that described in BLM, Technical Report 1734-3 (1996, 1999 Revision, Section V.C.2 and 3) should be used to help examiners make seasonal use estimations. The examiners must be trained to recognize the landscape appearance descriptions developed for the LSSC. Periodic review and/or recalibration during the field season may be necessary for maintaining consistency among examiners because of progressive phenological changes.

Making short-term estimates of seasonal use and collecting long-term (periodic multiple-indicator) data at the network of monitoring sites will help the LSSC to better understand the effects of management decisions over time – including potential adjustment of the thresholds described below. If there are additional areas of concern in a given pasture, use in these areas

[1] Landscape appearance descriptors were developed for use within the LSSC geography based on those described in Bureau of Land Management. (1996, 1999 Revision). *Utilization studies and residual measurements* (Technical Reference 1734-3) and Johnson, J.R., Reeves, G.W., Schmidt, D.W., and Skogberg, J.L. (1997). Estimating grass utilization using photographic guides. *SDSU Extension Circulars*. Paper 463. http://openprairie.sdstate.edu/extension_circ/463.

should also be taken into consideration. In pastures where no LSSC monitoring sites exist, key areas for seasonal use estimation will be designated.

Key species will be identified at each monitoring/seasonal use estimation location by members of the LSSC, and will include grasses and/or palatable woody species. These species will be native, when possible. Key native grass species may include blue grama (*Bouteloua gracilis*), James' galleta (*Pleuraphis jamesii*), Indian ricegrass (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), sand dropseed (*Sporobolus cryptandrus*), squirreltail (*Elymus elymoides*), western wheatgrass (*Pascopyrum smithii*), prairie Junegrass (*Koeleria macrantha*), needlegrasses (*Achnatherum* spp.), muttongrass (*Poa fendleriana*), sedges (*Carex* spp.), fescues (*Festuca* spp.), alpine timothy (*Phleum alpinum*). Where native grass presence is insufficient to effectively monitor, such exotic grasses as crested wheatgrass (*Agropyron* cristatum), smooth brome (*Bromus inermis*), and Kentucky bluegrass (*Poa pratensis*) may be monitored. Key woody species may include aspen (*Populus tremuloides*) and willows (*Salix* spp.) or other palatable species.

Thresholds of seasonal use to adjust the duration of grazing a particular pasture differ based on assessment of the pasture's ecological integrity and functionality[1] as follows:

- <u>Pastures with HIGH Ecological Integrity and Functionality</u>.   Livestock movement will be initiated when seasonal use of key species in the key area(s) of the pasture reaches approximately 40% -- as indicated by the following landscape appearance description:

  All fully accessible areas of the pasture are grazed. Points of concentration or overuse are limited to about 5% of the accessible area. Approximately 25% percent of current seedstalks remain intact. About 40% of the available forage on key species appears to have been utilized.

  Key palatable woody species appear rather uniformly utilized, however at least approximately 60% of the available leader growth remains intact.

  These thresholds apply to both extending and shortening the duration of use of a pasture with HIGH ecological integrity and functionality; however, extending the duration of use of a pasture with HIGH ecological integrity and functionality will only be

[1] An initial assessment of ecological integrity and functionality for each pasture is provided in **Appendix C**. Attachments to this appendix describe how ecological integrity and functionality for each pasture will be assessed going forward.

done following on-site confirmation by the BLM or FS. It is incumbent upon the operators to notify agency personal as early as possible about a potential extension of time in a pasture so the agency confirmation can be provided before the scheduled move date.

- <u>Pastures with MODERATE Ecological Integrity and Functionality</u>. Livestock movement will be initiated when seasonal use of key species in the key area(s) of the pasture reaches approximately 30% -- as indicated by the following landscape appearance description:

  Most of the accessible pasture shows grazing. Little or no use of poor forage. Key grass species have been topped, skimmed, or grazed in patches. There is little evidence of trailing to grazing. Approximately seventy percent of current seedstalks remain intact. Most young plants are undamaged.

  There is obvious evidence of leader use of key palatable woody species. However, the available leaders appear cropped or browsed in patches and at least approximately 70% of the available leader growth remains intact.

  These thresholds only apply to shortening the duration of use of a pasture with MODERATE ecological integrity and functionality. Cattle will be advanced to the next pasture on schedule if the observed seasonal use at that time is determined to be at or below 30% to help improve soil condition and/or the vigor of key species.

- <u>Pastures with LOW Ecological Integrity and Functionality</u>. Livestock movement will be initiated when seasonal use of key species in the key area(s) of the pasture reaches approximately 20% -- as indicated by the following landscape appearance description:

  Accessible areas of the pasture appear practically undisturbed when viewed obliquely. Only choice plants and favored areas near water, trails, or shade appear to be grazed. The key species have the appearance of very light grazing. Plants may be topped or slightly used. Current seedstalks and young plants are little disturbed.

  Key palatable woody species have the appearance of very light use. The available leaders are little disturbed.

  These thresholds only apply to shortening the duration of use of a pasture with LOW ecological integrity and functionality. Cattle will be advanced to the next pasture on schedule if the observed seasonal use at that time is observed to be at or below 20% to help improve soil condition and/or the vigor of key species.

The protocol and visual guides for estimating use described by McKinney (1997)[1] may be of some utility to examiners in identification of the appropriate landscape appearance descriptor.

Other Considerations. Documentation of the day each pasture is exited (for High, Medium and Low integrity and functionality pastures) will allow a cumulative record of the pattern of early and extended exits, providing for both adaptive management and public accountability.

At five high or moderate integrity pastures each year, a utilization cage will be used and key native grasses will be clipped and weighed within one week of a majority of the cattle exiting the pasture for quantitative calibration of visual estimates with measured use. The utilization cages will be rotated through different pastures every year unless the clip-and-weigh indicates a particular pasture was 10% over the estimated utilization, in which case the pasture will again contain a clip-and-weigh utilization cage the following year. A utilization cage followed by clip-and-weigh within one week of a majority of the cattle exiting the pasture will be placed annually in each low integrity pasture. Results of clip-and-weigh will be retained in the pasture record.

In areas where there is concern about level of use, the producers' range consultant has historically collected some quantitative data on seasonal use (i.e., by measuring plant weight prior to livestock entry into a pasture, during use of the pasture, at the end of livestock use, and at the end of the growing season). These data may also be used to prompt livestock movement.

Livestock Behavior

Livestock behavior will also be observed and used as a trigger. Initiating movement to the next pasture may be appropriate if livestock begin reusing plants that have already been grazed, returning to specific areas of a pasture, or are "banking" against pasture fence lines.

Precipitation Events

Moving livestock to the next pasture on a rain event within a week of a scheduled rotation may be appropriate to promote plant vigor.

[1] McKinney, E. (1997). It may be utilization, but is it management? *Rangelands* 19(3), 4-7.

References

Bureau of Land Management. (1996, 1999 Revision). *Utilization studies and residual measurements* (Technical Reference 1734-3).

Johnson, J.R., Reeves, G.W., Schmidt, D.W., and Skogberg, J.L. (1997). Estimating grass utilization using photographic guides. *SDSU Extension Circulars*. Paper 463. http://openprairie.sdstate.edu/extension_circ/463.

McKinney, E. (1997). It may be utilization, but is it management?. *Rangelands* 19(3), 4-7.

Appendix E, Attachment 1. Description of How Ecological Integrity and Functionality Will Be Assessed Going Forward

Introduction

The initial ranking of pasture ecological condition was provided by the producers' range consultant and agreed upon by the LSSC as a starting point. We recommend that during 2017 the ecological integrity and functionality of each pasture be assessed and rated. These baseline assessments will allow confirmation and/or adjustment of the ecological condition status for each pasture. Subsequent follow-up assessments should occur when credible information suggests there may have been a change in ecological integrity and functionality.

Where appropriate[1] Ecological Site Descriptions (ESDs) are available, assessment of ecological integrity and functionality by pasture should be completed following the protocol described in *Interpreting Indicators of Rangeland Health* (Pellant et al., 2005), which is used by the BLM and Forest Service. Interpreting Indicators of Rangeland Health (IIRH) is a qualitative assessment technique that considers 17 indicators. When applied by knowledgeable, experienced land managers and technical experts – in association with quantitative monitoring[2] – it can be used to:

- Provide a preliminary evaluation of soil/site stability, hydrologic function, and biotic integrity
- Communicate fundamental ecological concepts to a wide variety of audiences
- Improve communication among interest groups by focusing discussion on critical ecosystem properties and processes
- Provide early warnings of potential problems and opportunities by helping identify areas that are potentially at risk of ecological degradation or where resource problems currently exist

The protocol is NOT to be used to:

- Identify the cause(s) of resource problems
- Independently trigger grazing and other management changes
- Determine trend

This assessment protocol requires a good understanding of ecological processes, vegetation, and soils for each site to which it is applied. The quality and consistency of evaluations is

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[1] The appropriateness of available ESDs should be agreed to among those who will be involved in conducting the assessment.

[2] This quantitative monitoring includes LSSC monitoring at 30 locations as well as data collected by the land management agencies and other credible sources.

improved when two or more individuals (e.g., ecologist and soil scientist) work together. Use of the protocol within the LSSC geography should be done collaboratively – drawing upon the full diversity of expertise of members of the collaboration and our agency advisers.

The product of this qualitative assessment is not a single rating of rangeland health (or "ecological integrity and functionality" for purposes of the LSSC), but an assessment of three components called attributes (**Table 1**).

Table 1. The three attributes of rangeland health and the rating categories for each attribute.

Degree of Departure from Expected Levels	Soil/Site Stability	Hydrologic Function	Biotic Integrity
Extreme to Total			
Moderate to Extreme			
Moderate			
Slight to Moderate			
None to Slight			

Definitions of these three interrelated attributes are:

Soil/Site Stability. The capacity of an area to limit redistribution and loss of soil resources (including nutrients and organic matter) by wind and water.

Hydrologic Function. The capacity of an area to capture, store, and safely release water from rainfall, run-off, and snowmelt (where relevant), to resist a reduction in this capacity, and to recover this capacity when a reduction does occur.

Biotic Integrity. The capacity of the biotic community to support ecological processes within the normal range of variability expected for the site, to resist a loss in the capacity to support these processes, and to recover this capacity when losses do occur.

Each of these attributes is summarized at the end of the Evaluation Sheet based upon a preponderance of evidence approach using applicable qualitative indicators. Examples of qualitative indicators for each attribute are displayed in **Table 2**. The result is a preliminary assessment that may be modified with the interpretation of applicable quantitative monitoring and inventory data. Support or rationale for the original rating and any modification will be documented.

Table 2. Examples of qualitative indicators for the three attributes of rangeland health.

Soil/Site Stability	Hydrologic Function	Biotic Integrity
• Rills • Water Flow Patterns • Pedestals/Terracettes • Bare Ground • Gullies • Wind-scoured, blowout, depositional areas • Litter movement • Soil surface resistance to erosion • Soil surface loss or degradation • Soil compaction layer	• Rills • Water Flow Patterns • Pedestals/Terracettes • Bare Ground • Gullies • Soil surface resistance to erosion • Soil surface loss or degradation • Plant community composition and distribution relative to infiltration and runoff • Soil compaction layer • Litter amount	• Soil surface resistance to erosion • Soil surface loss or degradation • Soil compaction layer • Functional/structural groups • Plant mortality/decadence • Litter amount • Annual production • Invasive plants • Reproductive capability of perennial plants

Within the Context of the LSSC, assignment of an ecological integrity and functionality rating by pasture will be based on the conclusions of the IIRH assessment as outlined in Table 3.

Table 3. Definition of LSSC ecological integrity and functionality categories relative to IIRH assessment conclusions.

Characteristics of Pastures by Ecological Integrity and Functionality Category		
HIGH	**MODERATE**	**LOW**
The degree of departure from expected levels is assessed as "none to slight" for all three attributes.	The degree of departure from expected levels is assessed as no lower than "moderate" for any of the three attributes.	The degree of departure from expected levels is assessed as "moderate to extreme" (or worse) for at least one of the three attributes.

Where appropriate ESDs are not available, assessment of ecological integrity and functionality by pasture should be completed using the protocols in *Describing Indicators of Rangeland Health (DIRH)*, currently under development by Pellant et al. and being used by BLM and Forest

Service (**Attachment 2**). This protocol requires examination of the same 17 indicators used in IIRH, but rather than assess degree of departure from expected conditions, describes those indicators by assigning them to one of five "condition classes."

For the purposes of assessing ecological integrity and functionality of pastures within the LSSC geography using the DIRH methodology, a similar approach as described above for IIRH is recommended. Following assignment of the indicators for each of the three attribute categories to a condition class, **Table 4 will be used** to assign the pasture to one of three levels of ecological integrity and functionality.

Table 4. Definition of LSSC ecological integrity and functionality categories relative to DIRH assessment conclusions.

Characteristics of Pastures by Ecological Integrity and Functionality Category		
HIGH	**MODERATE**	**LOW**
The overall condition class is assessed as "1" for all three attributes.	The overall condition class is assessed as no lower than "3" for any of the three attributes.	The overall condition class is assessed as "4 or 5" for at least one of the three attributes.

Appendix E, Attachment 2: Reference Sheet and Evaluation Matrix Development: Describing Indicators of Rangeland Health

Introduction

This attachment describes a new tool, 'Describing Indicators of Rangeland Health' (DIRH) which is used to describe the current status of the 17 indicators without a pre-defined reference. This tool is designed to be used in three applications:

(1) Evaluations where a reference sheet is not yet available, but will be developed in the future. This allows the evaluation to be completed in the future, after the reference sheet is developed (Table 1).

(2) Reference sheet development. DIRH is applied to reference sites to define the range of variability in the reference state.

(3) Evaluation matrix development. DIRH is applied to describe the range of variability in an ecological site for each of the indicators.

Table 1. Determination of when to use DIRH instead of IIRH to collect information necessary for a future IIRH evaluation (i.e. Status Class 3 only).

Soil Survey/ESD Status Class	Soil survey status	ESD status	ID Soil Map Unit Component?	ID Ecological Site?	Complete IIRH? (version 4 or later)**	Complete all other methods?
1	Soil survey exists	ESD exists*	Yes	Yes	Yes	Yes
2	No soil survey, but soils comparable to soil described in another soil survey within the MLRA.	Ecological sites described for MLRA, including precip zone for NRI point.	Yes	Yes	Yes	Yes
3	No relevant soil info	Ecological sites not described for MLRA***	No. Follow DIRH instructions.	No	No. Follow DIRH instructions.	Yes

*If a soil survey exists, it should at least have range sites identified.
** Develop a reference sheet if one does not exist.
*** All the ESDs within the MLRA have not been completed, and the ESD for the NRI point does not exist.

Instructions for applying DIRH

Step 1. Describe the soil in the evaluation area (see below).

Step 2. Collect the following quantitative data:

- Cover and composition using Line-Point Intercept (LPI) method (minimum 100 points – 200 recommended) and plot species search (BLM/NRCS/NRI standard methods – see MMGSSE).
- Soil stability kit (minimum 9 surface samples - 18 recommended) (BLM/NRCS/NRI standard methods – see MMGSSE).
- Annual production (estimate – ideally use double sampling method described in MMGSSE).
- Take standard plot photos (MMGSSE or NRI) supplemented with any that may help a future evaluator make an evaluation based on a future reference sheet and the information in Table 2.

Table 2. Describing Indicators of Rangeland Health (DIRH) Matrix. *Where there are multiple criteria listed for an indicator, choose the class with the best match.* As a last resort, select the 'median' class for all of the criteria. For example, #2-Water Flow Patterns, includes three criteria: length, density, and intensity of water flow patterns. A site with long, common, occasionally connected water flow patterns would fall into Class 3.

Indicator	Class 5	Class 4	Class 3	Class 2	Class 1	Notes
1. Rills. Small, intermittent watercourses with steep sides. Rills are generally linear. Est. length/width _____x ______	Widespread (>10) AND long (>2')	Common (>5) AND long (>2').	Common (>5) OR long (>2').	Very few (<5) AND short (<2').	Not present.	Are they connected to water flow patterns Y or N

Indicator	Class 5	Class 4	Class 3	Class 2	Class 1	Notes
2. Water Flow Patterns. Soil surface patterns caused by runoff. Indicated by litter, soil, gravel redistribution. Steep cuts may occur on one side (see #1).	Very long (50') numerous; unstable with active erosion; almost always connected.	Long (20-50'), very common, and usually connected. Erosion and deposition areas very common.	Moderately long (5-20'), common and often connected. Erosion and deposition areas common.	Very short, (<5'), rare and occasionall y connected. Erosion and deposition areas rare.	None.	
3. Pedestals and/or Terracettes. Plants or rocks appear elevated because of soil loss around them. Does not include deposition of soil on top of plant (check level of root-shoot interface).	Widespread throughout area. Common exposed roots.	Common, in flow paths. Occasional exposed roots.	Common, in flow paths. Roots rarely exposed.	Few in flow paths and interspaces only. No exposed roots.	None.	
4. Bare Ground. Percent soil surface *not* covered by vegetation, rock, plant litter, mosses, lichens or dark algal crusts. Percent will be generated from LPI. Use classes to describe connectivity. Connectivity is broken by plants rooted on the site, whether annual or	Nearly always connected.	Generally connected	Occasionall y connected	Rarely connected	Not connected	

Indicator	Class 5	Class 4	Class 3	Class 2	Class 1	Notes
perennial. Refer to transect # _________ for quantitative data line point.						
5. Gullies. Large, intermittent watercourses with steep sides. Stable gullies have less steep sides with plants and no active erosion at the headcut (top) or top of sides.	Active headcut, whether or not in evaluation area, unstable sides.	Active headcut, whether or not in evaluation area, partially stable sides.	Active headcut, whether or not in evaluation area, stable sides with a few nickpoints.	Inactive. Stable throughout .	None.	
6. Wind Scoured, Blowout and/or Depositional Areas	Widespread throughout area (>50% area affected)	Many (25-50% of area affected)	Common. (10-25% of area affected)	Few.	None.	
7. Litter Movement **(wind or water).** Distance moved by different sizes of plant litter (needles, leaves, bark, branches). Indicated by litter accumulation in low, flat (water) or protect (wind) areas.	Fine litter moved very long distances (>20'). Large litter moved moderate distances(<10').	Fine litter moved long distances (<20'). Large litter moved short distances(< 5').	Fine litter moved moderate distances (<10') Large litter moved very short distances(< 2').	Fine litter moved short distances (<5').	Fine litter moved very short distances (<2').	

Indicator		Class 5	Class 4	Class 3	Class 2	Class 1	Notes
8. Soil Surface Resistance to Erosion. (From Soil Stability Kit or Soil Condition Form) Refer to soil structure worksheet # _____ pg ______	Class 6 – Stability Class 1. 50% of structural integrity lost within 5 seconds	Stability Class -2. 50% lost 5-30 seconds after insertion.	Stability Class- 3. 50% lost 30-300 seconds after insertion.	Stability Class -4. 10-25% of soil remains on sieve after 5 dipping cycles.	Stability Class -5. 25-75% of soil remains on sieve after 5 dipping cycles.	Stability Class -6. 75-100% of soil remains on sieve after 5 dipping cycles	
9. Soil Surface Loss and Degradation. Take at least 1 photo of the top 30cm under a typical plant or patch of plant, and in an interspace. See photo to make determination. Refer to soil		Soil surface horizon absent	Soil loss or degradation severe throughout site.	Moderate soil loss or degradation in plant interspaces with some degradation beneath plant canopies.	Some soil loss has occurred and/or soil structure show signs in plant interspaces.	Soil surface horizon intact.	

Indicator	Class 5	Class 4	Class 3	Class 2	Class 1	Notes
structure work sheet # _____ pg _______ photo #______						
10. Cover of plants that help increase water infiltration and reduce runoff (FROM LPI + CANOPY GAP). See Long-term trend study # _______ for percentage.	75-100%	50-75%	25-50%	10-25%	<10%	Refer to transect # _______ for % canopy cover.
11. Compaction Layer (below soil surface). Dense soil layers with horizontal (platy) structure at least 2" (can be up to 8-10") below the soil surface which affect or reduce root penetration (e.g. grow horizontally.) Refer to soil assessment and the soil compaction section	Extensive; severely restricts water movement and root penetration.	Common. Greatly restricts water movement and root penetration.	Moderately wide-spread, moderately restricts water movement and root penetration.	Rarely present or thin and weakly restrictive to infiltration and root penetration.	None.	Refer to soil structure worksheet #_______ pg _________. Yes No
12. Plant F/S Groups. (FROM LPI) See Long-term trend Study #_______ for information.	Number of F/S groups greatly reduced **and/or** Relative dominance	Number of F/S groups reduced **and/or** One dominant group and/or one or more sub-	Number of F/S groups moderately reduced **and/or** One or more sub-dominant F/S groups	Number of F/S groups slightly reduced **and/or** Relative dominance of F/S groups has	F/S groups and number of species in each group closely match that expected for the site.	

Indicator	Class 5	Class 4	Class 3	Class 2	Class 1	Notes
	of F/S groups has been dramatically altered **and/or** Number of species within F/S groups dramatically reduced.	dominate group replaced by F/S groups not expected for the site **and/or** Number of species within F/S groups significantly reduced.	replaced by F/S groups not expected for the site **and/or** Number of species within F/S groups moderately reduced.	been modified from that expected for the site **and/or** number of species within F/S slightly reduced		
13. Plant Mortality/ Decadence*. Proportion of aboveground biomass that is dead or decadent.	>50%	25-50%	10-25%	2-10%	<2%	
14. Litter Amount. From LPI. See Long-term trend #_____.						
15. Annual Production. Record as ocular estimate. *Dependent on current water year.	Below Average		Average	Above Average		
16. Invasive Plants. FROM LPI. See long term trend Study #__________	Yes No ID: ____________________________					

Indicator	Class 5	Class 4	Class 3	Class 2	Class 1	Notes
17. Reproductive capability of perennial plants. Reflected in ability of PERENNIAL plants, but not invasive plants, to produce seeds or tillers, and to recover following grazing, drought or other disturbance.	At least 10% of the individuals of <50% of the species capable of reproduction, including <50% of the species that are dominant or sub-dominant.	At least 10% of the individuals of 50% of the species capable of reproduction, including 50% of the species that are dominant or sub-dominant.	At least 10% of the individuals of 75% of the species capable of reproduction, including 75% of the species that are dominant or sub-dominant.	At least 10% of the individuals of 90% of the species capable of reproduction, including 90% of the species that are dominant or sub-dominant.	Nearly all perennial species capable of reproduction, including all that are currently dominant or sub-dominant.	

Basic Soil Profile Description Instructions

1. Decide on the appropriate location to describe the soil, avoiding any unusual features on the site (eg, rodent mounds, cultural or historical resources, etc).

2. Dig a small hole (1-2 shovel widths in diameter) to a depth of at least 20-inches. Expose a clean face on at least one side, being careful to avoid disturbing the soil surface at the top of this one side. If disturbed, simply shave off the face of the profile back to the point of no disturbance.
3. Take a vertical photograph of the profile face created in step 2. Ideally, the entire face should be completely in the sun or shade, and all of the face should be captured in 1 photo. Affix a tape measure along the profile depth, with the zero-mark at the top of the profile. Figure 1 shows the type of photo that should be obtained. Label digital photo filenames per guidance in Item B.5 above.
4. Identify horizons based on differences in:
    a. Soil texture of mineral horizons
    b. Soil color
    c. Soil structure (Figure 3)
    d. Percent rock fragments (particles >2mm diameter).

For most soils encountered in unmapped areas, there will be between 2-4 horizons. Active dune soils may only have 1 horizon. More than 4 horizons are possible, but very unlikely except in highly stratified alluvial deposits. If you need a refresher in texturing soils by hand, refer to this lesson guide before going to the field, or print it and bring it with you: http://soils.usda.gov/education/resources/lessons/texture/ .

5. For mineral soils, record the **soil surface texture** code and **surface texture** modifier code (if applicable) in the "Soil Component ID" box on the Soils screen of the CASI. Refer to Table 3 for texture codes, and Table 4 for texture modifier codes.

6. For each identified mineral soil horizon, determine and record the following as a Soil Note under the Tools menu on the CASI:
   a. Depth in inches (continuous from soil surface = 0).
   b. Texture, as determined by hand (Figure 2), using codes shown in Table 3.
   c. Soil texture modifier name based on Table 5; or the estimated %-rock fragment content by volume recorded as a numerical value.
   d. Effervescence class (using 1N or 1M HCl) (Table 6).
   e. Any unusual features such as redoximorphic features (mottles), $CaCO_3$ (caliche) nodules, concretions, etc.

   A 4-inch or larger diameter, 2mm sieve can be very helpful in separating the fine and coarse material for determining texture and coarse fragment content.

Figure 1. **Example of soil profile photo.** (Your profile will be smaller since it is a shovel-dug hole; key points are to capture important features with consistent natural lighting.)

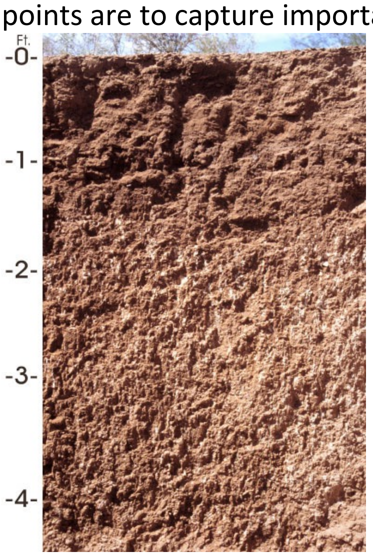


Figure 2. **Soil Texture Triangle**

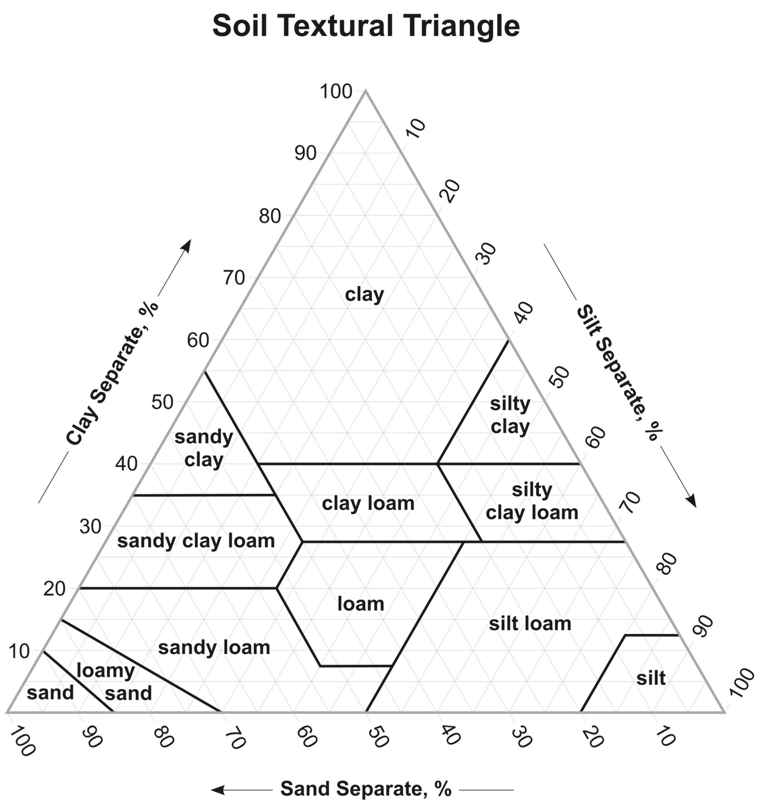


Table 3. **Soil Texture Codes based on texture class (record the Code in the CASI).**

Texture Class or Subclass	Code	Texture Class or Subclass	Code
Coarse sand	cos	Very Fine Sandy Loam	vfsl
Sand	s	Loam	l
Fine Sand	fs	Silt Loam	sil
Very Fine Sand	vfs	Silt	sil
Loamy Coarse Sand	lcos	Sandy Clay Loam	scl
Loamy Sand	ls	Clay Loam	cl
Loamy Fine Sand	lfs	Silty Clay Loam	sicl
Loamy Very Fine Sand	lvfs	Sandy Clay	sc
Coarse Sandy Loam	cosl	Silty Clay	sic
Sandy Loam	sl	Clay	c
Fine Sandy Loam	fsl		

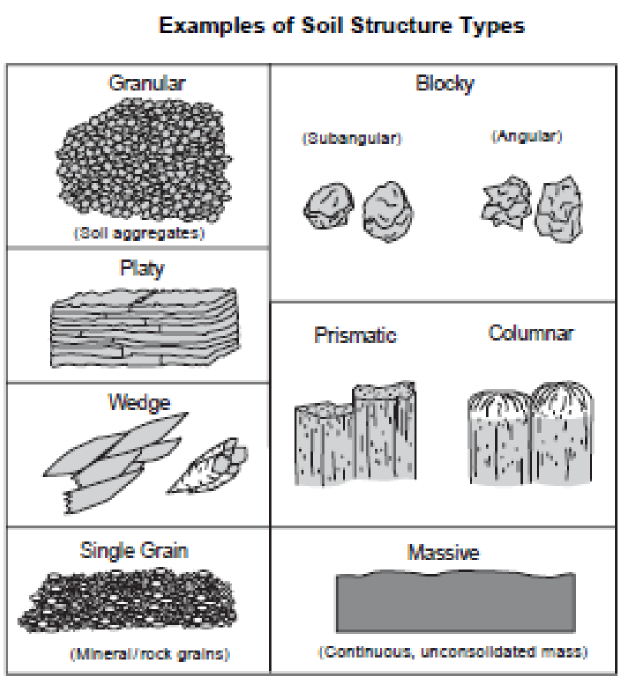
Table 4. **Texture Modifier Codes (record the Code, not the rock fragment name, in the CASI).**

ROCK FRAGMENTS: Size & Quantity 1/	**Code**	**Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By (name size) 1/:**
ROCK FRAGMENTS (> 2 mm; ≥ Strongly Cemented)		
Gravelly	GR	≥ 15% but < 35% gravel
Fine Gravelly	GRF	≥15% but < 35% fine gravel
Medium Gravelly	GRM	≥15% but < 35% med. gravel
Coarse Gravelly	GRC	≥ 15% but < 35% coarse gravel
Very Gravelly	GRV	≥ 35% but < 60% gravel
Extremely Gravelly	GRX	≥ 60% but < 90% gravel
Cobbly	CB	≥ 15% but < 35% cobbles
Very Cobbly	CBV	≥ 35% but < 60% cobbles
Extremely Cobbly	CBX	≥ 60% but < 90% cobbles
Stony	ST	≥ 15% but < 35% stones
Very Stony	STV	≥ 35% but < 60% stones
Extremely Stony	STX	≥ 60% but < 90% stones
Bouldery	BY	≥ 15% but < 35% boulders
Very Bouldery	BYV	≥ 35% but < 60% boulders
Extremely Bouldery	BYX	≥ 60% but < 90% boulders
Channery	CN	≥ 15% but < 35% channers
Very Channery	CNV	≥ 35% but < 60% channers
Extremely Channery	CNX	≥ 60% but < 90% channers
Flaggy	FL	≥ 15% but < 35% flagstones
Very Flaggy	FLV	≥ 35% but < 60% flagstones
Extremely Flaggy	FLX	≥ 60% but < 90% flagstones
PARAROCK FRAGMENTS (> 2 mm; < Strongly Cemented) 2/, 3/		

Parabouldery	PBY	(same criteria as bouldery)
Very Parabouldery	PBYV	(same criteria as very bouldery)
Extr. Parabouldery	PBYX	(same criteria as ext. bouldery)
etc.	etc.	(same criteria as non-para)

1/ The "Quantity" modifier (e.g., very) is based on the total rock fragment content. The "Size" modifier (e.g., cobbly) is independently based on the largest, dominant fragment size. For a mixture of sizes (e.g., gravel and stones), a smaller size–class is named only if its quantity (%) sufficiently exceeds that of a larger size–class. For field texture determination, a smaller size-class must exceed 2 times the quantity (vol. %) of a larger size class before it is named (e.g., 30% gravel and 14% stones = very gravelly, but 20% gravel and 14% stones = stony). For more explicit naming criteria see NSSH-Part 618, Exhibit 618.11(Soil Survey Staff, 2001b).
2/ Use "Para" prefix if the rock fragments are soft (i.e., meet criteria for "para"). [Rupture Resistance- Cementation Class is < Strongly Cemented, and do not slake (slake test: ≈3cm (1 inch) diam. block, air dried, then submerged in water for ≥ 1 hour; collapse / disaggregation = "slaking").]
3/ For "Para" codes, add "P" to "Size" and "Quantity" code terms. Precedes noun codes and follows quantity adjectives, e.g., paragravelly = PGR; very paragravelly = VPGR.

Figure 3. **Examples of soil structure types and their definitions.**



Type	Code		Criteria: (definition)
	Conv.	NASIS	
NATURAL SOIL STRUCTURAL UNITS (pedogenic structure)			
Granular	gr	GR	Small polyhedrals, with curved or very irregular faces.
Angular Blocky	abk	ABK	Polyhedrals with faces that intersect at sharp angles (planes).
Subangular Blocky	sbk	SBK	Polyhedrals with sub-rounded and planar faces, lack sharp angles.
Platy	pl	PL	Flat and tabular-like units.
Wedge	—	WEG	Elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides; not limited to vertic materials.
Prismatic	pr	PR	Vertically elongated units with flat tops.
Columnar	cpr	COL	Vertically elongated units with rounded tops which commonly are "bleached".
STRUCTURELESS			
Single Grain	sg	SGR	No structural units; entirely noncoherent; e.g., loose sand.
Massive	m	MA	No structural units; material is a coherent mass (not necessarily cemented).

Table 5. Texture Modifier Criteria: Rock Fragment Content by Volume

Rock Fragment Content by % Volume (required)	Rock Fragment Modifier Usage (optional)
<15	No texture adjective is used (noun only; e.g., loam).
15 to <35	Use adjective for appropriate size; e.g., *gravelly.*
35 to <60	Use "very" with the appropriate size adjective; e.g., *very gravelly.*
60 to <90	Use "extremely" with the appropriate size adjective; e.g., *extremely gravelly.*
90+	No adjective or modifier. If 10% or less fine earth, use the appropriate noun for the dominant size class; e.g., *gravel.* Use terms in lieu of texture.

Table 6. Effervescence Class

Effervescence Class	Visible Criteria
Non-effervescence (NE)	No bubbles form.
Very Slightly Effervescent (VS)	Few bubbles form.
Slightly Effervescent (SL)	Numerous bubbles form.
Strongly Effervescent (ST)	Bubbles form a low foam.
Violently Effervescent (VE)	Bubbles form a thick foam.

Appendix F. Recommended Drought[1] Strategy

Drought is a common visitor to the LSSC geography, and may increase in the region with climate change. Grazing livestock in this environment requires advance planning and proactive action to ensure social, economic and ecological sustainability. Recommended principles and guidelines for preparing for drought and adjusting grazing management during and following drought are outlined below. Failure to follow these principles and guidelines will adversely impact ecological conditions and functionality and animal performance (e.g., weaning weights can be reduced dramatically, yearling gains will suffer, and pregnancy rates will drop, especially in first calf heifers).

Anticipating Drought

- Planning for the next drought must be completed in advance because management options decline as drought intensifies. The primary goal is to protect native plants before and during drought years to facilitate fast recovery in years of normal or higher precipitation.
- A key factor to remember is that all of the options need to be carefully evaluated based on their cost of implementation
- Prepare for drought by increasing the health of the overall operation and maximizing flexibility**.** Producers who focus on increasing flexibility and maximizing the health of resources are more likely to find solutions during drought that minimize painful decisions with limited resources.
- A SWOT analysis is a tool that can be beneficial for helping to understand potential drought risks and benefits. SWOT is an acronym for doing an analysis of strengths, weaknesses, opportunities, and threats posed by drought. The strengths (S) and weaknesses (W) originate from within the operation; they are internal factors that influence ranch or farm performance. The opportunities (O) and threats (T) originate from outside the operation; they are external factors.

Considerations to Guide Management During Drought

- During drought, plants may go dormant before the end of the normal growing season.
- Drought increases the rate of natural die-off of plant roots. Drought-stricken vegetation should be managed to promote root replacement, native biodiversity, and ecological function.
- Effects on plant growth depend on severity and duration of the drought as well as the health of the vegetation going into the drought.

[1] Two definitions of "drought" are equally meaningful:
– A prolonged and abnormal moisture deficiency. [Huschke, R.E. (1959). Drought. In *Glossary of meteorology*. (pp. 638). Boston, MA: American Meteorological Society.].
– A condition of insufficient moisture caused by a deficit in precipitation over some time period. [McKee, T.B., Doesken, N.J., and Kleist, J. M. (1993). Proceedings from In the relationship of drought frequency and duration to time scales: *Eighth Conference on Applied Climatology*. Anaheim, CA.].

- Because there is less forage production, the pastures cannot be stocked at the same levels as in normal years.
- Spring growth will likely be delayed and the growth rate will be slower than normal.
- The effects of drought are intensified at poorer allotment conditions. Plant communities in "fair" condition are often more severely affected by drought than plant communities in "good" to "excellent" condition. Vegetation condition also influences the rate of recovery in forage production after drought.
- If plant growth is stopped by drought, forage quality may decline rapidly because livestock selectively graze the highest quality forage first.
- The rate of decline in forage quantity and quality during drought is much more pronounced than in an average growing season.
- Poor water quality may decrease forage intake.
- Haul water when water quality and quantity decreases during drought.

Management Options

- Once the drought is recognized, reduce the herd as soon as possible so it is in balance with the forage supply.
- Market prices tend to be the highest at the beginning of a regional drought; reducing the herd based on projected drought, or the early stages of drought may have economic advantages.
- Sell cows before weight loss.
- Reduce base cow herd numbers and replace with yearling heifers. The yearlings can be sold without drastically reducing the base herd.
- Graze pastures for shorter duration. If the drought persists, continue to reduce utilization to protect native biodiversity and ecological function.
- Reductions in base herd numbers may be necessary.
- Confinement and feeding animals may be necessary.
- Calves may need to be weaned and sold early.
- Cull the base herd heavily – broken mouths, poor udders, etc. Cull cows on behavioral characteristics. Some individual cows will range farther than others. Keep these and cull lazy cows. Bad characteristics are passed from mother to offspring. Pregnancy check early and cull open and late calvers.
- Check bulls for breeding soundness. Cull low fertility bulls to reduce the number that need to be maintained for the base herd.
- Cow condition is very important and high protein supplements may be necessary.
- Market prices for cattle and beef fluctuate both seasonally and cyclically.
  When you combine such phenomena with local conditions, such as drought, the amount of risk may be amplified.
- Using drought management strategies, a producer may be able to exploit the market fluctuations and use them to alleviate heavy financial losses.

Tax Considerations

- Taxes are often overlooked and need to be thought about. A forced liquidation could dramatically increase the tax liability.
- It may be advantageous, from a tax management standpoint, to purchase supplemental feed and then confine the herd.

Management After Drought

- After the drought breaks, plants may show growth above average height and have an abundance of seed heads. However, beware; because of plant mortality during the drought, the forage production may be lower than normal because there are fewer plants.
- The color green can have a psychological effect, producing temptation to restock at normal rates. Remember, animals graze plants, not acres. Stocking rates need to be moderate. Overgrazing after a drought will damage surviving plants; the plants will require a much longer period of rest and recovery, to be followed by conservative small increases in restocking plans. The years following drought should be devoted as much as possible to improving plant vigor and restoration of protective residual vegetation and plant liter. Leave adequate plant cover for hydrologic condition of pastures.

Conclusion

There is **no cookbook** approach for proper drought management. It boils down to the fact that sound grazing management practices that sustain or improve allotment condition will ultimately enable good drought management. Well planned grazing practices that promote conservative forage use while sustaining high vigor of plants are good insurance against drought.

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APPENDIX G. Recommended Infrastructure to Facilitate Socially, Economically, and Ecologically Sustainable Livestock Grazing on the LSSC Landscape [1] [2]

PROJECT RANKING LOWRY-Sample

Priority Lowry	Project Name	Project Type	Cost	Responsible for Cost	Timing	NEPA Requirements
1	Thompson Flat Well	Water/Well-Solar Pump	$32,000	GIP - 75% . Producer - 25%	Spring of 2017	San Juan County property - No NEPA
2	Trout Water Spring developments	Water	$21,000	GIP - 75% . Producer - 25%	Spring of 2017	BLM needs to start for this project
3	Chets Ledge	Water	$10,000	Producer – BLM - GIP	2017	BLM
4	Browns Hole	Water	$35,000	TBD – need to sort lowry & luis's component	ASAP - 2017	BLM
5	Chicken Creek Boundary Adjustment	Fence	$17,000	Producer-FS	ASAP - 2017	FS
6	La Sal Creek/La Sal Pass Boundary Adjustment	Fence	$12,000	Producer-FS-GIP	2017	FS
7	South Mountain Saddle Gap	Fence	$3,500	Producer-FS-GIP	2018	FS
8	Buck Hollow 4-Way Well	Water/Well-Solar Pump	$42,000	Producer-FS-GIP	2018	FS
9	Buck Hollow Lackey Spring	Water/Solar Pump	$42,000	Producer-FS	2018	FS

[1] LSSC members did not reach consensus on vegetation treatments, and they have not been included in this list of recommended infrastructure.
[2] Infrastructure projects will be funded by both public and private funds, varying project by project. The amount of private funds and each source of public funds used (BLM, Forest Service, State, other) will be reported for each project and open to the public.

10	Deer Springs Water Development Expansion	Water	$25,000	Producer-FS-GIP	2018	FS
11	Soup Rock	Fence	$23,000	Producer-BLM	2020	BLM

Priority Lowry	**Project Name**	**Project Type**	**Cost**	**Responsible for Cost**	**Timing**	**NEPA Requirements**
12	Carpenter, Pole, Lackey Water	Water/Well-Solar Pump	$35,000	Producer-FS	2020	FS
13	Pine Ridge Boundary Adjustment	Fence	$15,000	FS	2018	FS
14	Pine Ridge Fuels Project	Fence[3]	TBD	TBD	2019	FS
15	Carpenter Basin - Pole Canyon Trails	Trail	TBD	FS Recreation	2019	FS
16	Flat Iron North	Fence	$22,500	Producer-BLM-GIP	2020	BLM
17	Buck Hollow Green Gate	Water/Solar Pump	$35,000	TBD	2020	FS
18	Bell Springs	Water	$5,000	Producer-FS-GIP	2020	No NEPA needed. Existing structures present
19	Brother-In-Law	Water	$5,000	TBD	2020	No NEPA needed. Existing structures present
20	Silvey's Pocket Spring Development	Water	$35,000	Producer-BLM-GIP	2021	BLM

[3] Pine Ridge Fence depends on fuels vegetation treatment to get the fence project started

Priority Lowry	Project Name	Project Type	Cost	Responsible for Cost	Timing	NEPA Requirements
21	Flat Iron Rock Ponds	Water/Ponds	$11,000	Producer-BLM	2021	BLM
22	Anticline Water Haul System	Water	$15,000	TBD	2021	BLM
23	Goodman Trail Maintenance	Trail Maintenance	TBD	BLM	TBD	BLM
24	Wilson Arch Hwy Undershot - mile Marker 102	Undershot	TBD	Producer-UDOT/DWR	TBD	UDOT/DNR
	Three-Mile Well System Expansion	Water/Well-Electric Pump	LSSC members deferred decision on these two projects; they intend to re-evaluate the need and benefits of these projects after other infrastructure projects listed above have been put in place.			
	Trough Flats Well System Expansion	Water/Well-Electric Pump	LSSC members deferred decision on these two projects; they intend to re-evaluate the need and benefits of these projects after other infrastructure projects listed above have been put in place.			

	Critical to implementation of the grazing recommendations and is urgent
	Critical to implementation of the grazing recommendations but not near as urgent
	Important to enhance the benefits of the grazing recommendations but not urgent

PROJECT RANKING LUIS-Sample

Priority Luis	Project Name	Project Type	Cost	Responsible for Cost	Timing	NEPA Requirements
1	Aloca	Fence	$12,000	Homeowners - 50 %. Producer 50%	ASAP - 2016	FS/BLM
2	Mud Springs/Box Divison	Weaning Corral	$20,000	TBD	ASAP - 2017	SITLA
3	Brown's Hole Spring	Water/Solar Pump	$35,000	Producer-GIP-MAWP	ASAP - 2017	BLM
4	Black Ridge	Fence/Cattle Guard	$6,000	Producer-SJ County	ASAP - 2017	BLM
5	Amasa's Back Pipeline Extension	Water	$30,000	Producer-BLM-GIP	2018	FS/BLM
6	Cottonwood Spring	Water/Solar Pump	$60,000	Producer-BLM-GIP	2019	BLM
7	Sal's Cabin Spring Development	Water	$40,000	Producer-MAWP-FS-GIP	2017	Existing structures - No NEPA required
8	Sal’s Cabin Bike cattle guard & walk around gate	Cattle Guard	$1,000	FS-Trail Crew	2017	FS
9	Lower Dorry Spring Pipeline extension	Water	$20,000	Producer-FS-MAWP-GIP	2018	FS

10	Upper Dorry Spring Development	Water	$15,000	Producer-MAWP-FS-GIP	2017	Existing structures - No NEPA required
11	Lower Dorry Spring Development	Water	$5,000	Producer-MAWP-FS-GIP	2017	Existing structures - No NEPA required
12	Bliss Spring Development	Water	$6,130	GIP - 50 %. Producer 50%	Spring of 2017	Existing structures. No NEPA required
13	South Cabin Water	Water	$5,000	Producer-MAWP-FS-GIP	2018	Existing structures. No NEPA required
14	South Moores Range Water Upgrade	Water	$5,000	Producer-FS	Currently happening	Existing structures. No NEPA required
15	Cottonwood East & West	Fence	$23,000	Producer-BLM-GIP	2018	BLM
Priority Luis	**Project Name**	**Project Type**	**Cost**	**Responsible for Cost**	**Timing**	**NEPA Requirements**
16	Brown's Hole Nipples Well	Water/Well-Solar Pump	$30,000	Producer-BLM-GIP	2019	BLM
17	Black Ridge Artesian Well	Water/Well-Solar Pump	$30,000	Producer-BLM-GIP	2019	BLM
18	Mail Box/Muleshoe Point Trail	Fence	$5,000	SPEAR	2020	BLM
19	Turn Back Spring Development	Water	$7,000	Producer-BLM-GIP	2020	BLM
20	Mail Box Undershot	Fence	$6,000	TBD	2020	BLM
21	Muleshoe Point	Water	$15,000	Producer-BLM	2020	BLM
22	Upper Dorry/Brumley Boundary	Fence	$12,000	Producer-FS	2020	FS

23	Watershed	Fence	$12,000	Producer-FS	2020	Maintenance on existing project
Priority Luis	**Project Name**	**Project Type**	**Cost**		**Timing**	**NEPA Requirements**
24	Lower Kane Spring Developments	Water	$30,000	TBD	2020	BLM

(red)	Critical to implementation of the grazing recommendations and is urgent.
(yellow)	Critical to implementation of the grazing recommendations but not near as urgent
(green)	Important to enhance the benefits of the grazing recommendations but not urgent

FENCING-Sample

PROJECT NAME:	PROJECT TYPE:	FENCE LENGTH (FEET):	CATTLE GUARD - TYPE & LENGTH:	FENCE REMOVAL LENGTH:	OWNERSHIP:	NOTES:
Aloca	Fence	15840			Private/FS/BLM	
Soup Rock	Fence	10560	1-32' 1-24'		BLM	
Cottonwood East & West	Fence	7920		1764	BLM	
Pine Ridge Boundary Adjustment	Fence	10560		2640	FS	*Pine Ridge Fence depends on fuels vegetation treatment to get the fence project started
Black Ridge	Fence	400	1-24'		BLM	
Flat Iron North	Fence	5280			SITLA/BLM	
South Mountain Saddle Gap	Fence	1320			FS	
Turkey Ridge Pasture	Fence	7920			BLM	
Mud Springs/The Box Division	Fence/Corral	3960			BLM	Existing fence needs to be re-built.
Chicken Creek Boundary Adjustment	Fence	2640		5280	FS	
La Sal Creek/La Sal Pass Boundary Adjustment	Fence	3950		3950	FS	
Mail Box/Muleshoe Point Trail	Fence	500	2 ATV		BLM	
Mail Box Undershot	Fence	500	2 ATV		BLM	Swinging wash fence

Upper Dorry/Brumley Boundary	Fence	300			FS	Replacing old brush fence with wire fencing.
Watershed	Fence				FS	Maintenance agreement or removal.
Sal's Cabin Bicycle Cattle Guard & Walk around gate	Cattle Guard		1		FS	
	Total New (Feet):	71650		13634		
	(Miles):	13.6		3		

WATER – Sample

PROJECT NAME	*PROJECT TYPE*	*PIPE/ LENGTH (FEET)*	*# SPRING BOX*	*# WELLS*	*# SOLAR PUMPS*	*# ELECTRIC PUMP*	*# TROUGHS & Gal. Size*	*# Ponds*	*# STORAGE TANKS & Gal. Size*	*OWNERSHIP*	*NOTES*
Buck Hollow 4-Way Well	Well-Solar Pump	10560		1	1		3-1200		1--5000 Gal.	FS	Rework existing well
Buck Hollow Lackey Spring	Solar Pump	18480	1		1		4-1200		2--5000 Gal.	FS	A surface solar pump at Lackey Spring.
Deer Springs expansion/Benefitting Coyote	Extending Pipeline	10560					5-1200			FS	

Amasa's Back Pipeline Extension	Pipeline Extension	10560					5-600			FS/BLM	
Chets Ledge	Spring Development	7500	1		1		2-1200		1 – 1100 1-5000	BLM	
Brown's Hole Spring	Solar Pump	15840	1		1		3-1200		1--1000 Gal.	BLM	Take water both directions from the canyon bottom. One line would go out into Cottonwood East.
Cottonwood Spring	Solar Pump	8000	1		1		4-1000		1--10000 Gal.	BLM	Pole fencing needed around the source.
Carpenter, Pole, Lackey Water	Well-Solar Pump			1	1						Drill Well and then place Solar pump
Sal's Cabin Spring Development	Spring Development	5280	1				2-350			FS	spring box is existing

Buck Hollow Green Gate	Solar Pump	11000		1			4-1200		1--5000 Gal.	FS/BLM	
Bell Springs	Pipeline /Redevelopment	1000					1-1200			FS/BLM	
Brother in-Law	Pipeline /Redevelopment	10000					2-1200		1--10000 Gal.		
Silvey's Pocket Spring Delopment	Spring Development	5280	1				2-1000		2--1500 Gal.	BLM	
Upper Dorry Spring Development	Spring Development	500	1				1-350			FS	
Lower Dorry Spring Development	Spring Development	10560	1				2-350			FS	
Bliss Spring Development	Spring Development	7920	3				3-1000			BLM	Three separate springs.
South Cabin Water	Spring Development	1400	1				2-350				

Trout Water Spring Developments	Spring Development	31680	3				6-500			BLM	Three separate springs.
Turn Back Spring Development	Spring Development	2500	1				1-1200			BLM	
South Moores Range Water Upgrade	Spring Development	500	5				5-350			FS	Maintaining/Upgrading Existing spring developments
Brown's Hole Nipples Well	Well-Solar Pump	50		1	1		1-1200			BLM	Rework existing well and then put in solar pump
Anticline Water Haul System	Water-Haul System	1000					2-1200		1--5000 Gal.	BLM	
Three-Mile Well System Expansion	Well-Electric Pump	84480		1		1	12-1200		3--10000 Gal.	BLM	Well will be drilled and then electric pump installed.

Muleshoe Point	Ponds							3		BLM	Cleaning/ Maintenance
Trough Flats Well System Expansion	Well-Electric Pump	52800		1		1	8-1200		3--10000 Gal.	BLM	Well will be drilled and then electric pump installed.
Thompson Flat Well	Well-Solar Pump	1500		1	1		1-1200		Existing	BLM	Rework existing well
Flat Iron Rock Ponds	Ponds							4			Four separate pond sites on slick rock.
Black Ridge Artesian Well	Well-Solar Pump	2640		1	1		2-1000			BLM	Drill Well and then place Solar pump
Lower Kane Spring Developments	Spring Development	800	3				3-500			BLM/SITLA	Three separate springs, one on SITLA. Hunter Canyon, Trough Springs, & Hurrah Pass.

Lower Dorry Spring Pipeline Extension	Spring Development	2640	1				1-1200			FS	

PROJECT NAME	*PROJECT TYPE*	*PIPE/ LENGTH (FEET)*	*# SPRING BOX*	*# WELLS*	*# SOLAR PUMPS*	*# ELECTRIC PUMP*	*# TROUGHS & Gal. Size*	*# Ponds*	*# STORAGE TANKS & Gal. Size*	*OWNERSHIP*	*NOTES*
Total:	**Number**		23	8	8	2	83	7	16		
	Feet	307,530									
	Miles	57.8									
	Gallons						293,900		109,000		

Appendix H. LSSC: High Value Areas without Grazing

The diverse group of stakeholders that make up the La Sal Sustainability Collaboration (LSSC) came to the table with a goal of improved ecological resilience. The Grand Canyon Trust and Sierra Club hoped to identify some large no grazing areas for comparison with grazed areas across common vegetation types. The LSSC wrestled unsuccessfully with the challenge of finding truly representative reference areas for the geography of the LSSC. In lieu of suitable reference areas, we settled on constructing 2-4 acre three-way exclosures at 8 key grazing sites we believe will reflect changes in grazing management to help provide insight into:

a. Ecological potential absent domestic livestock grazing.
b. Ecological potential absent all ungulate grazing.
c. Rates of change in ecological conditions with and without ungulate grazing.
d. Relative influence of climate/weather versus grazing.

At these sites, we will compare progress towards Desired Conditions using a Similarity Index.

During the course of the dialogue shared interest in identifying areas where other multiple use values may benefit from exclusion of domestic grazing emerged. Members of the LSSC have identified two High Value areas that we believe domestic livestock use could be excluded with little or no impact on the economic sustainability of the producers. A description of those areas and management recommendations to meet our shared desires for them follows. They represent less than 1% of the permitted area. See Figure 1 below.

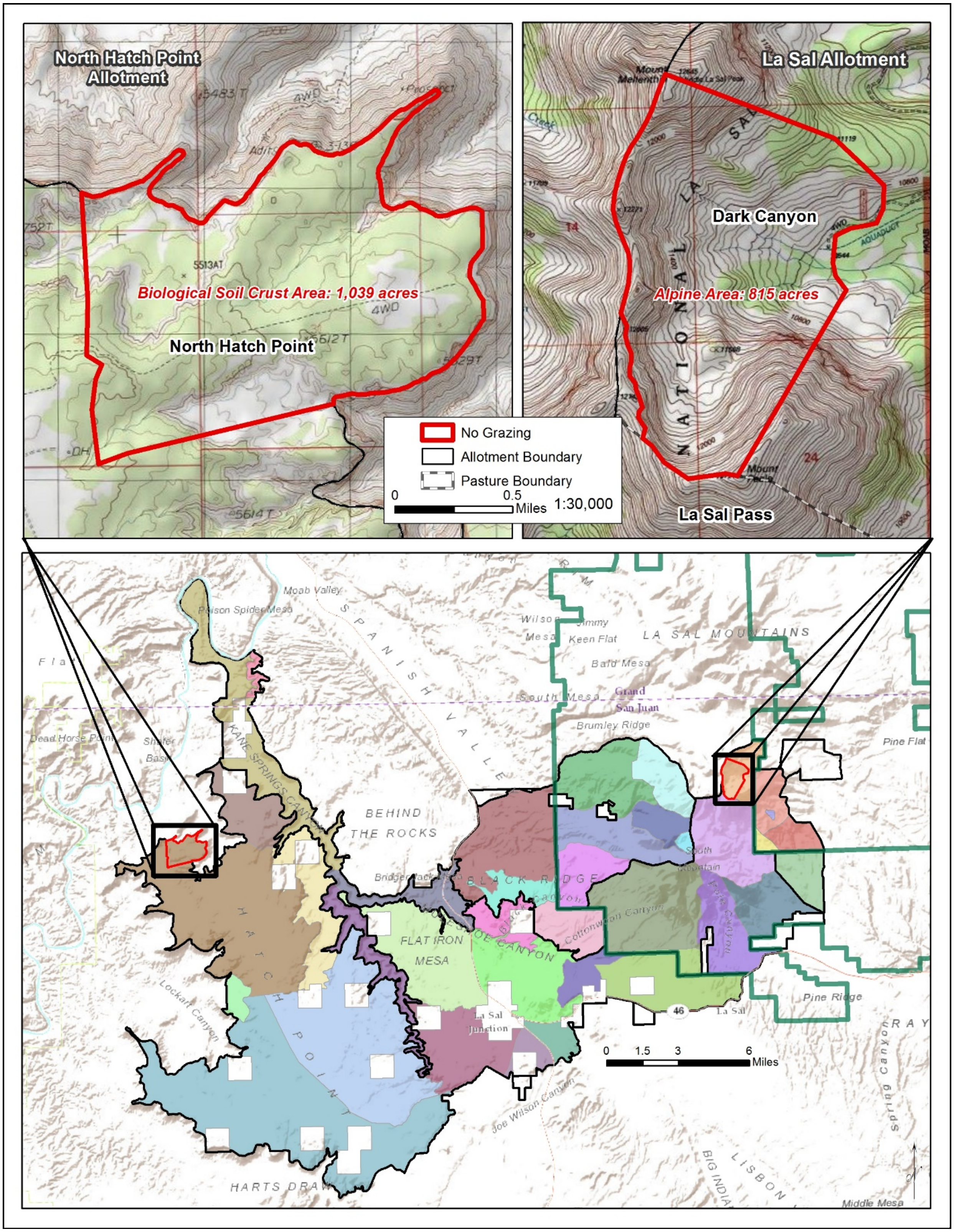

Figure 1: Designated ungrazed areas within the LSSC allotments

Turkey Ridge Biological Soil Crust Area
A portion of Hatch Point, Turkey Ridge (Figure 1), has outstanding biological soil crust resources (Figure 2). Not only is the crust extremely well developed, it is undisturbed over a large area (1,039 Acres). The area offers the public a rare multiple-use resource, that is, well-developed biological soil crust on an active, BLM administered, grazing allotment. The permittee has agreed to not place water or supplements that would attract livestock to the area. No fence will be constructed at this time.

Upper Dark Canyon Alpine and Subalpine Area
Upper Dark Canyon alpine and subalpine area (Fig. 3), is located below the north face of Mt. Peale (12,721 ft.) the tallest peak in the La Sal Mountains. This area is currently grazed to varying degrees of intensity depending upon the year. The area offers tremendous wildflower resources that provide quality pollinator habitat. The Forest Service, like other federal agencies, has recently been charged with protecting pollinator habitat. The recreation opportunities in the area are also tremendous. The area will be kept free of cattle by a combination of riding and using supplements at lower elevations. If fencing is found to be a necessary adaptive management strategy, it will be the responsibility of the Forest Service and/or conservation community.

Appendix I. Monitoring Plan: *La Sal Sustainability Collaboration*

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Monitoring Plan: *La Sal Sustainability Collaboration*

Introduction

The La Sal Sustainability Collaboration (LSSC) has recommended changes in management of certain private, state, and federal lands in the Southern La Sal Mountains and surrounding canyon lands – specifically in regard to livestock grazing, wildland fire, forest health, beaver management, watershed restoration, native fish reintroduction, and recreational fishing opportunities. The intention behind these management recommendations is to promote the social, economic, administrative, and ecological vibrancy, sustainability, and resiliency of this landscape. This monitoring plan was developed to assess progress towards that intention. The monitoring plan represents what the collaboration believes is practical and sustainable over the long-run. We expect to learn as we implement, and will review the need to modify this plan at least annually.

Overview

This monitoring plan is organized around issues and desired conditions, in four categories of indicators: Social, Economic, Administrative, and Ecological. Table 1 provides an overview of the suite of issues, desired conditions, indicators of success for each category, and some monitoring results that would be expected to prompt discussion. A description of the protocol for assessing each indicator follows, including:

- Methods
- Location
- Timing/Frequency
- Responsibility

In regard to <u>monitoring methods</u>, an effort was made to use well documented, scientifically credible methods with the least resource intensive requirements that would allow assessment of progress toward LSSC desired conditions. In identification of suitable methods we gave preference to those that were embraced by the Collaborative Group on Sustainable Grazing for National Forests in Southern Utah, specifically Appendix 9 of their Final Report and Recommendations (i.e., *Simple Methods for Measuring Indicators of Ecologically Sustainable Grazing* -- Gay, et al, 2012) and/or are used by or compatible with agency partner methodologies.

In regard to <u>monitoring locations</u>, the description provides a sense of the types of areas where monitoring will occur and specific geo-referenced locations where appropriate.

In regard to <u>monitoring timing/frequency</u>, the description provides information about both *when* during the year data are collected and *how often* that data is to be collected.

In regard to <u>monitoring responsibility</u>, the identified agency/agencies or organization that has/have committed to fund and conduct data collection and analysis of the particular indicator is documented. Members of the LSSC support transparency and inclusivity in data collection to assess progress toward our desired conditions. Although only one, or a small subset of the members of the LSSC may be listed as "responsible" in this monitoring plan, we expect continued collaboration in the collection and analysis of the data and communication of the results. If the responsible entity is unable to fulfill its commitment, they will immediately notify the LSSC and alternative arrangements will be made as soon as possible.

Table 1. Overview of the suite of issues, desired conditions, associated indicators of success, and discussion prompts for the La Sal Sustainability Collaboration's efforts to promote social, economic, administrative, and ecological vibrancy, sustainability, and resiliency.

SOCIAL SUSTAINABILITY				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**[1]	
			Trend[2]	**Numeric Value**
1. Conflict over the presence of cattle in Pack Creek residential areas	*An agreement is in place that eliminates cattle access to the Pack Creek residential area and is supported by residents, land managers, and producers.*	**S11:** Formalized agreement	N/A	An agreement is reached within 2 years
2. Interaction among various public land users result in diminishment of values important to those users	*There is understanding and respect among public land users for all multiple uses allowed within the LSSC geography.*	**S21:** Number and nature of complaints per year	Decreasing	N/A
3. Opportunity for future generations to graze livestock on public lands	*There is a socially and economically viable opportunity for future generations to graze livestock on public lands within the LSSC geography.*	**S31:** The suite of Social, Economic, Administrative and Ecological indicators – taken in whole – are the best indicator for meeting this desired condition	Various (see trends for the other indicators)	Various (see numeric values for other indicators)

[1] If desired trends or numeric values associated with an indicator are apparently not being met, a discussion among LSSC members, agency representatives and perhaps others is triggered to deepen understanding of: 1) factors that may be contributing to the observed results; 2) the potential need for modification of management practices, the indicator, or the discussion prompt; and 3) recommended changes.

[2] Social, Economic and Administrative indicator trends will be tracked by permit/authorization or enterprise. The terms "**increasing**" or "**decreasing**" are intended to indicate the desired direction of movement for trends. We recognize there are finite limits to the amount of change that is possible for these indicators (i.e., under ideal conditions increasing trends will approach some "potential" that is ≤ 100% and decreasing trends will approach some "potential" that is ≥ 0%).

ECONOMIC SUSTAINABILITY				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
1. Costs associated with management (private and public)	*Positive net economic return to producers is sufficient to sustain their businesses.*	**En11:** Inflation adjusted producer costs of management (relative to production)	Stable or Decreasing	N/A
	There is a positive net societal economic return on public and private investment.	**En12:** Economic return to society on public and private investment	Increasing	N/A
2. Production quantity and reliability	*Production is reliably high relative to permitted or authorized numbers.*	**En21:** Pounds of weaned calf per cow exposed	Increasing	N/A
		En22: AUMs grazed relative to permitted or authorized numbers	N/A	*Full permitted or authorized numbers can be run full time when trend and numeric values associated with the ecological sustainability indicators are achieved, all pastures are rated as having high ecological integrity and functionality,[1] and the full numbers would not be expected to reverse the trends*
3. Water distribution, cross-fencing, and other infrastructure to effectively manage livestock	*Fences, water developments, handling facilities, vegetative treatments, etc... needed to support economic (and ecological) sustainability are proposed, approved, in place, and maintained.*	**En31:** Progress toward prioritized list of identified infrastructure needs	N/A	Identified infrastructure is in place and maintained

[1] Unless livestock grazing is not responsible for or impeding attainment of high ecological integrity and functionality.

ECONOMIC SUSTAINABILITY – Cont'd.				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
4. Other economic benefits	*A broad spectrum of other economic benefits are realized as a result of proposed management changes within the LSSC geography.*	**En41:** Water quantity/value	Increasing	N/A
		En42: Wildfire suppression and rehabilitation costs	Decreasing	N/A
		En43 : Costs to repair or replace wildfire-damaged built infrastructure	Decreasing	N/A
		En44: Size/quantity of naturally produced trout	Increasing	N/A

ADMINISTRATIVE SUSTAINABILITY				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
1. Permit or Authorization transfer, modification, and compliance	*Permit/Authorization transfer and modification*[1] *takes place in a timely manner.*	**A11:** Timing of permit and authorization transfer and modification	N/A	Date of transfer and modification completion[2]
	Permit/Authorization compliance is not an issue.	**A12:** Number and nature of compliance issues/year	Decreasing	N/A
2. Inter- and intra-agency coordination and communication with permittees	*Effective inter- and intra-agency coordination is the norm.*	**A21:** Number/year of surprises/conflicts related to grazing within the LSSC area -- Between agencies -- Within agencies	Decreasing	N/A

[1] Permit/Authorization modifications to address LSSC recommendations

[2] The FS is to complete permit transfer within FY 2017 and permit modification within 2018. Transfer and modification of BLM authorizations are to be completed in FY 2018 and 2019 respectively.

ADMINISTRATIVE SUSTAINABILITY – Cont'd.				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
2. Inter- and intra-agency coordination and communication with permittees (*Continued*)	*Effective communication between agency personnel and the permittees is the norm.*	**A22:** Number/year of surprises resulting from inadequate communication from -- Permittees -- Agency Personnel	Decreasing	N/A

ECOLOGICAL SUSTAINABILITY				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend[1]	**Numeric Value**[2]
1. Biological Diversity of Native Flora	*Plant communities are composed of diverse and vigorous native grasses, forbs, shrubs and trees.* (Note: We are not recommending indicators for the Pinyon/Juniper community type. Except where mechanical treatments may be implemented, we don't believe we are likely to be able to measure differences associated	***Composition and Cover by Species***		
		Eg11a: Grass Communities[3]	Increasing diversity and % cover of native grasses and forbs	65% similarity of improvement
		Eg11b: Sagebrush Communities	Increasing diversity and % cover of native grasses, forbs, and shrubs	65% similarity of improvement
		Eg11c: Aspen Communities	Increasing diversity and % cover of native grasses, forbs, shrubs, and trees	65% similarity of improvement
		Eg11d: Riparian Communities	Increasing diversity and % cover of native grasses, forbs, shrubs and trees	65% similarity of improvement
		Eg11e: Mountain Brush Communities	Increasing diversity and % cover of native grasses and forbs	N/A

[1] Ecological trends will be tracked at all sample sites where data are being collected for one or more indicators. Unless otherwise specified, where the terms "**increasing**" or "**decreasing**" are used, this speaks to conditions that are *moving toward, or are static, near, or at site potential (or in the absence of defined potential – which is expected to be the norm – indicators are increasing toward 100% and decreasing toward 0% or static at what appears to be the potential of the site).*

[2] Numeric values for some ecological indicators only apply to the 7 sample sites where exclosures are established for comparison purposes. In these instances the numeric value is expressed as a percent similarity of conditions outside the exclosure to those inside and only apply when conditions inside the exclosure are improving toward the desired condition. If conditions outside are not improving at least 65% of the rate they are improving within the exclosure a discussion will be prompted to discover "why" and explore the need for management changes.

[3] Grass communities refer to plant communities that are dominated by grass-like species (e.g., grass, sedges, rushes).

ECOLOGICAL SUSTAINABILITY – Cont'd.				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
1. Biological Diversity of Native Flora (*Continued)*	with modification of livestock grazing practices. If mechanical treatments of the P/J community type are done, we expect the results to be monitored as part of the project.)			
	Plant communities are composed of diverse and vigorous native grasses, forbs, shrubs and trees.	***Vigor***		
		Eg12a: Grass Communities	Increasing grass production	65% similarity of improvement
			Increasing grass seedhead production	65% similarity of improvement
			Increasing forb seedhead production	65% similarity of improvement
		Eg12b: Sagebrush Communities	Increasing grass production	65% similarity of improvement
			Increasing grass seedhead production	65% similarity of improvement
			Increasing forb seedhead production	65% similarity of improvement
			Increasing evidence of regeneration and recruitment of sagebrush	65% similarity of improvement
		Eg12c: Aspen Communities	Increasing grass production	65% similarity of improvement
			Increasing grass seedhead production	65% similarity of improvement
			Increasing forb seedhead production	65% similarity of improvement
			Increasing evidence of regeneration and recruitment of aspen	65% similarity of improvement
			Increasing incidence of leader growth after grazing	65% similarity of improvement
		Eg12d: Riparian Communities	Increasing grass production	65% similarity of improvement
			Increasing grass seedhead production	65% similarity of improvement
			Increasing forb seedhead production	65% similarity of improvement

ECOLOGICAL SUSTAINABILITY – Cont'd.				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
1. Biological Diversity of Native Flora (*Continued)*		**Eg12d:** Riparian Communities (*Continued*)	Increasing evidence of regeneration and recruitment (i.e., willow and cottonwood)	65% similarity of improvement
			Increasing incidence of leader growth after grazing	65% similarity of improvement
		Eg12e: Mountain Brush Communities	Increasing grass production	N/A
			Increasing grass seedhead production	N/A
			Increasing forb seedhead production	N/A
2. Biological Diversity of Native Fauna	*Stream habitat is occupied by native fish assemblages.*	**Eg21:** Miles of stream with self-supporting native fish assemblages	At least doubled within 10 years	<u>Present</u> in at least the following systems: • Deer Springs Creek • La Sal Creek • Beaver Creek
3. Watershed Health – Riparian/Aquatic	*Water quality meets or exceeds state and federal requirements.*[1]	**Eg31a:** Temperature	Continues to meet or exceed	Maximum: 20 C Maximum change: 2 C
		Eg31b: Nutrients	Continues to meet or exceed	N/A
		Eg31c: Dissolved Oxygen	Continues to meet or exceed	30 day Avg: 6.5 mg/L 7 day Avg: 9.5/5.0 mg/L Minimum: 8.0/4.0 mg/L[2]
		Eg31d: Macroinvertebrate community composition	Continues to meet or exceed	>80 % of expected biota
	Water quantity is maintained or increased.	**Eg32:** Summer base flows above the first point of diversion (indexed to precipitation).	Maintained or increased over-time, as measured at: Deer Springs Creek • La Sal Creek • Beaver Creek	N/A

[1] Numeric values displayed for indicators Eg 31a-c apply to trout streams only.

[2] Where two threshold values are shown for 7 day average and minimum dissolved oxygen, the first number applies when early life stages of coldwater game fish are present; the second number applies when only other life stages are present.

ECOLOGICAL SUSTAINABILITY – Cont'd.				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
3. Watershed Health – Riparian/Aquatic (*Continued*)	*Riparian/aquatic habitats are highly functional and resilient.*	**Eg33a:** Acres and condition of riparian areas (landscape scale)	Increasing	N/A
		Eg33b: Mechanical trampling/shearing of streambanks	Decreasing	N/A
		Eg33c: Portion of streambanks with deeply rooted vegetation[1]	Increasing	N/A
		Eg33d: Pool length	Increasing	N/A
		Eg33e: Pool depth	Increasing	N/A
		Eg33f: Sedimentation of Substrate	Decreasing	N/A
	Riparian/aquatic habitats are highly functional and resilient. Riparian/aquatic habitats are highly functional and resilient. (Continued)	**Eg33g:** Macroinvertebrate community composition	*Same as Eg31d above.*	
	Spring sources and their associated wetlands are protected from impacts while providing controlled, off-site drinking water for domestic ungulates and wildlife (subject to valid existing rights)..	**Eg34:** Number of springs protected	Increasing	N/A
4. Watershed Health – Uncharacteristic Wildfire	*Low risk of uncharacteristic wildfire.*	**Eg41:** Fuel loading	Decreasing	N/A
		Eg42: Burn severity	Decreasing	N/A
		Eg43: Sediment delivered	Decreasing	N/A
		Eg44: TES habitat impacted	Decreasing	N/A

[1] See **Attachment 9** for list of deeply rooted species that contribute to bank stability.

ECOLOGICAL SUSTAINABILITY – Cont'd.				
Issue	**Desired Condition**	**Indicator**	**Discussion Prompt**	
			Trend	**Numeric Value**
5. Watershed Health – Other (Soil Characteristics and Undesirable Species)	Soils are stable and improving.	**Eg51a:** % plant litter	Increasing	65% similarity of improvement
		Eg51b: % plant basal cover (by species)	Increasing	65% similarity of improvement
		Eg51c: % moss/lichen	Increasing	65% similarity of improvement
		Eg51d: % bare soil (with and without canopy cover)	Decreasing	65% similarity of improvement
		Eg51e: % area with active soil erosion and pedestaling	Decreasing	65% similarity of improvement
		Eg51f: Soil Stability	Increasing	65% similarity of improvement
	Undesirable plant species have little or no influence on ecological functionality and resilience of LSSC landscape.	**Eg52a:** Percent cover and density of undesirable species (by species at sample sites)	Not increasing (decreasing where possible)	65% similarity of improvement
		Eg52b: Area dominated by invasive species (by species at LSSC landscape scale)	Not increasing (decreasing where possible)	N/A

Protocols

<u>SOCIAL INDICATORS</u>

S11: Formalized agreement to address conflict associated with Pack Creek residential area.

Methods: Track resolution of livestock conflicts in the Pack Creek residential area.

Location: Pack Creek Residential Area

Timing/Frequency: Ongoing/annual until resolved (To be accomplished within 2 years)

Responsibility: LSSC members and Forest Service

S21: Number of user/producer complaints per year.

Methods: Track the number and type of documented conflicts among users by allotment. Documented conflicts include written or electronic correspondence received by the agencies that highlight a specific conflict experienced by users (e.g., livestock grazers, recreationists) or cooperators (e.g., law enforcement agencies, elected officials). These conflicts will be reviewed and discussed at the semi-annual LSSC progress meeting. Trends in the number of conflicts among users will be assessed over time.

Location: LSSC wide, by allotment

Timing/Frequency: Ongoing/annual

Responsibility: Bureau of Land Management, Forest Service

S31: ***Opportunity for future generations to graze livestock on public lands.***

Methods: The probability there will be a socially and economically viable opportunity for future generations to graze livestock on public lands within the LSSC geography will be assessed considering the full suite of Social, Economic, Administrative and Ecological indicators. These trends will be reviewed and discussed at the semi-annual LSSC progress meeting.

Location: LSSC wide

Timing/Frequency: Ongoing/annual

Responsibility: LSSC members

<u>ECONOMIC INDICATORS</u>

En11: Inflation adjusted producer costs of management.

Methods: Costs of management will be tracked by a standard set of categories. A template to track these costs is included as **Attachment 1**. A baseline figure (using the UT Grazing Improvement Program cost list for FY17) will be calculated and used as an index against which future inflation adjusted producer costs of management will be compared. That is, the baseline index will be set at "100," and future costs communicated in reference to it (i.e., if inflation adjusted management costs increase by 5% the index for that year would be "105;" if inflation adjusted management costs decline by 5% the index for that year would be "95.") Inflation adjustments will be based on *the National Consumer Price Index.*

Location: By Enterprise

Timing/Frequency: Ongoing/Annual

Responsibility: Livestock producers (in partnership with Utah State University Extension and Utah Department of Agriculture and Food, Grazing Improvement Program)

En12: Economic return on public and private investment.

Methods: Public and private investment in <u>grazing infrastructure</u> will be tracked by a standard set of categories (see **Attachment 2** for template) to document all costs of infrastructure on state and federal lands within the LSSC. *Economic activity generated* by this grazing infrastructure will be determined using economic models similar to those used elsewhere in the State of Utah (Jakus et al 2013; Ward et al 2012). [1]

Location: By Enterprise

Timing/Frequency: Ongoing/Annual

Responsibility: Agencies and livestock producers (in partnership with Utah State University Extension and Utah Department of Agriculture and Food, Grazing Improvement Program).

En21: Pounds of weaned calf per cow exposed.

Methods: The National Cattlemen's Beef Association has adopted Standardized Performance Analysis (SPA) measures to evaluate the biological performance of the cow herd. Three variables are suggested as important to determining how the herd is doing:

1. Number of calves weaned per exposed female
2. Pounds weaned per exposed female
3. Pounds weaned per acre utilized

The first two of these three measures will be used to evaluate performance of LSSC cow herds. For publics lands grazing it is difficult to establish a figure for number of acres used making it virtually impossible to establish the third variable.

Location: By Enterprise

Timing/Frequency: Ongoing/Annual

Responsibility: Producers

En22: AUMs grazed relative to permitted or authorized numbers.[2]

Methods: Actual AUMs grazed will be tracked by State lease/Forest Service permit/BLM authorization by the livestock producers and compared to the numbers permitted/authorized by the agencies. Data will be summarized in the following format:

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[1] Although this is an indicator of economic sustainbility, for many of the public return on investment in grazing infrastructure is valued in terms of its contribution to social and ecological sustainability. Those benefits will be tracked by monitoring numerous social and ecological indicators.

[2] Full permitted or authorized numbers can be run when: 1) trend and numeric values associated with the ecological sustainability indicators are achieved; 2) all pastures are rated as having high ecological integrity and functionality (unless livestock grazing is not responsible for or impeding attainment of high ecological integrity and functionality), and 3) full numbers would not be expected to reverse these trends.

Enterprise	Permit or Authorization	Type and class of animal	Days in Pasture	Number of Animals	AUMs Used	AUMs allotted
Redd	A					
	B					
	C					
	D					
BLT	A					
	B					
	C					

Location: By permit or authorization

Timing/Frequency: Ongoing/Annual

Responsibility: Producers (actual use)/Agencies (authorized use)

En31*: *Progress toward list of identified infrastructure needs

Methods: Progress will be assessed against a prioritized list of fences, water developments, handling facilities, vegetative treatments, and other infrastructure needed to support economic (and ecological) sustainability. Progress towards completion of these infrastructure projects will be reviewed and discussed at the semi-annual LSSC meeting.

Location: LSSC wide

Timing/Frequency: Ongoing/Annual

Responsibility: Producers, Forest Service, Bureau of Land Management and State Lands

En41: Water value.

Methods: Instream flows, indexed to precipitation will be quantified per the methodology described for "summer base flow" indicator (**Eg32**). Any increases in indexed flow will be valued at $75/acre foot, as established by the United States Department of Interior, Bureau of Reclamation.[1]

Location: Deer Springs Creek, La Sal Creek, and Beaver Creek.

Timing/Frequency: Based on May – September flow measurements; analyzed annually, assessed every 5 years.

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1 Water Service Contract Among the United States of America, the Emery Water Conservancy District and the Cottonwood Creek Consolidated Irrigation Company #13-WC-40-521 (September 12, 2013). 2,168 acre feet of water per year (for 40 years) was acquired for $6.5 million.

Responsibility: Data collection by Southeast Utah Watershed Coordinator and Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring (Deer Springs Creek and La Sal Creek) and Forest Service (Beaver Creek). Analysis and assessment will be conducted by Grand Canyon Trust.

En42: Wildfire suppression and restoration costs.

Methods: Document annual fire suppression costs (for fires that are greater than ten acres in size or human-caused) and restoration costs (for fires greater than 500 acres in size) on the LSSC landscape. Wildfire suppression and restoration costs will be reviewed and discussed at the semi-annual LSSC progress meeting. Trends in costs will be assessed over time.

Location: LSSC-wide

Timing/Frequency: Ongoing/annual

Responsibility: Bureau of Land Management, Forest Service, State Lands

En43: Costs to repair or replace damaged built infrastructure.

Methods: Document costs to repair or replace damaged buildings or other constructed improvements (e.g., roads, communications infrastructure, fences, water infrastructure). Magnitude of damage will be reviewed and discussed at the semi-annual LSSC progress meeting. Trends in costs and magnitude of damage will be assessed over time.

Location: LSSC-wide

Timing/Frequency: Ongoing/annual

Responsibility: Bureau of Land Management, Forest Service, State Lands

En44: Size/quantity of naturally produced trout.

Methods: Approximate 0.1 mile sections of stream will be sampled with backpack electrofishing gear (Lockwood and Schneider, 2000). Block nets will be placed at both the downstream and upstream bounds to limit fish immigration and emigration. A minimum of two passes with electrofishing gear will be completed and collected fish will be held in live cages outside the study area. All fish collected will be enumerated and measured for total length and weight. Stocked and naturally produced trout will be distinguished to the extent possible. Fish population size (# naturally produced fish/mile) and 95% confidence intervals will be estimated using the Moran-Zippen (2 passes) or the Zippen method (> 2 passes) (Zippin, 1958; Seber and Le Cren, 1967). In some cases presence/absence surveys may only be necessary. Backpack electrofishing sites will vary in station length and catch may be reported as fish/h for these surveys.

Fish quality will be determined by average size, weight, and fish condition.

Location: LSSC landscape, those streams where we are actively trying to restore native cutthroat trout. (*Initially this includes: Deer Springs, La Sal, and Beaver Creeks.*)

Timing/Frequency: In August or September/ every 2 or 3 years. Baseline trout population characteristics will be collected in these streams prior to reintroduction of native trout. Initial reintroductions or fish stockings will be assessed the following year.

Responsibility: Utah Division of Wildlife Resources

<u>ADMINISTRATIVE INDICATORS</u>

A11: Timing of permit/authorization transfer and modification.

Methods: Document permit/authorization transfer and modification actions. Progress and/or needs will be reviewed and discussed at the semi-annual LSSC meeting.

Location: LSSC wide

Timing/Frequency: Ongoing/Annual until completed (FS to transfer/modify permits within FY 2017 and 2018 respectively; BLM to transfer/modify authorizations with FY 2018 and 2019 respectively)

Responsibility: Bureau of Land Management, Forest Service and State Lands

A12: Number and nature of compliance issues/year.

Methods: The number and type of compliance issues by allotment and pasture will be tracked. Compliance issues include those addressed by verbal or written contact with the producers and documented in agency files. These compliance issues will be reviewed and discussed at the semi-annual LSSC progress meeting. Trends in the number and type of compliance issues will be assessed over time.

Location: LSSC wide

Timing/Frequency: Ongoing/Annual

Responsibility: Bureau of Land Management, Forest Service and State Lands

A21: Number of surprises/conflicts related to grazing within the LSSC area (i.e., between agencies and within agencies).

Methods: Producers and land management agencies will keep a record of the nature and number of conflicts between and within agencies that adversely affect grazing management within the LSSC area by permit/authorization and allotment (e.g., differences in interpretation of law/regulation/policy between agencies; lack of coordination within agencies among program areas). These conflicts will be reviewed and discussed at the semi-annual LSSC progress meeting. Trends in the number and type of conflicts will be assessed over time.

Location: LSSC wide

Timing/Frequency: Ongoing/Annually

Responsibility: Producers, Bureau of Land Management, Forest Service and State Lands

A22: Number of surprises resulting from inadequate communication from permittees and agency personnel.

Methods: Producers and land management agencies will keep a record of the nature and number of "surprises" that adversely affect the quality of working relationships within the LSSC area by permit/authorization and allotment (e.g., failure to coordinate, lack of follow-through on commitments). These "surprises" will be reviewed and discussed at the semi-annual LSSC progress meeting. Trends in the nature and number of surprises will be assessed over time.

Location: LSSC wide

Timing/Frequency: Ongoing/Annually

Responsibility: Producers, Bureau of Land Management, Forest Service and State Lands

ECOLOGICAL INDICATORS

Information on the ecological indicators described below will be collected at georeferenced locations within key sites and associated exclosures[1] which are likely to inform conclusions about the effects of management on ecological conditions within the LSSC geography. The methods and guidance for LSSC selection of key sites is described in **Attachment 3.** It should also be noted that efforts have been made to collect information about as many indicators of ecological health as possible at each monitoring location. For example, most vegetation and soil parameter information will be collected along the same permanently located transects and, to the extent possible, aquatic condition indicators will be assessed in the same locations as the riparian vegetation and soil data are collected.

Eg11a-e: Plant composition/cover.

Methodology: The purpose of this method is to collect and measure changes in plant species composition and cover over time. It uses the standard line-point intercept method to collect species and ground cover at 5+ layers of the vegetation canopy: a top layer, 3 lower layers and at the soil surface. The method also includes a census of all plant species identified within 6 feet of both sides of all transects measured on the study site to provide species composition, as well as the camera on a stick method to compliment the species

[1] Exclosures will be constructed at 7 locations within the LSSC geography for comparison purposes.

and ground cover. Measurement will occur in grass, sagebrush, mountain brush, aspen and riparian community types.

Georeferenced Landscape Photo

Write the project name, site name, transect number, and date on the chalkboard. Make sure the lettering is large enough that it will be legible in the photo. Lean the chalkboard against the range pin to the side of the 0’ t-post at the beginning of the transect consistent with the direction of the transect. Make sure there is no vegetation (grass, etc.) blocking the lettering on the chalkboard. If there is, either remove the vegetation or move the chalkboard slightly until it is visible. Take a photo down the transect from a standing position. View the photo. The chalkboard should be centered and slightly up from the bottom of the photo. The sky should take up 1/4 to 1/3 of the top of the photo (if obstructed by trees, the horizon should be estimated). If the photo is taken on a site that has previously been measured, it is ideal to look at a copy of the previous photo so the new photo will be taken of the same area. The UTM location and date will be embedded on each photo. The LSSC encourages the use of cameras that provide automatic georeferences.

Transect Establishment

When the site is originally established, transects should be installed based on the key site criteria. The number of transects will range between one and five transects per site, based on the size of the area being monitored and the logistics of getting to the site. The number and configuration of transects on key sites with exclosures will be same within and outside the exclosure. Documentation of the rationale of number and configuration of transects will be given for each site in the monitoring notes and reports. If sites are established in locations where soils and vegetation are susceptible to trampling effects, transect locations and configurations should be designed to reduce negative impacts from repeated trampling during monitoring.

Each transect should be 100 feet long and a permanent t-post should be installed at the 0 point and just past the 100 foot point of the transect, unless circumstances do not allow the transects to be that length, in which case rationale and transect length should be recorded in the monitoring notes. Stretch a tape taut between the two t-posts. Take a GPS coordinate of each t-post, labeling the transect number and whether it is at the 0 point or 100 foot point. It is also recommended that a witness post be installed at the best place to park your vehicle and map/document the direction and distance between the witness post and the site. Document location and direction of each transect on site.

If the transect was previously established, then navigate from the witness post to the site and transect(s) using the instructions and GPS. Stretch the tape taut between the two t-posts in the directions described in the site descriptions.

Plant Census

Holding the middle of a 6-ft range pole (or PVC), walk down the right side of transect with the left end of the pole directly above the transect and record each plant species that is rooted under the range pole (the person carrying the pole should be about 3 feet to the right of the transect). After reaching the end of the transect, turn around and repeat on the other side of the transect. This will create a 12-ft belt transect where species composition will be recorded. This information is collected on the plant census data sheet. Any additional species noticed outside the 12-ft census belt should be recorded in the site notes, but will not be analyzed for the indicator.

Line-point Intercept Method

On each transect, every foot starting with the 1-ft mark, drop a pin flag that is at least 2.5 feet long and less than 1 mm in diameter next to the right side of the tape (while looking down the transect). The pin should be vertical. Record names of the species that touch the pin at the top layer, 3 lower layers, then one more layer at the soil surface. This is repeated every foot along the transect until 100 points are recorded (at the end point). This method is described by Herrick et al. (2009, p. 9), with the following modifications: Standing dead material will be recorded as "standing dead," along with its species name if it can be identified.

Line-point Intercept analysis

To calculate the percent cover of each species, count each of the 100 points that had the species present (top layer or one of the lower layers). This number is the percent cover of the species. The foliar canopy cover is calculated for each plant species that is recorded as the top layer. The percent bare ground cover is calculated as the total number of soil surface points that have bare ground without any other layer above it.

The percent cover of each species is then reported and compared with future recordings on the same transect. The classifications of invasive, native, grass, forb, etc. will be applied to each species and group statistics will be calculated. If multiple transects are measured for a site, the average percent cover is calculated for each species and ground cover classification. The appropriate statistical analysis will be applied to the changes over time.

Camera on a Stick

Stand at the beginning point of the transect. Adjust the camera's zoom so a photo of the ground will include approximately a 1-m^2 area. Stand on the left side of the transect facing right at the 10-ft point on the transect (so a photo straight down would have the transect along its bottom edge). Place the base of the monopod between your feet and position it so you can reach the shutter button. Use the level mounted to the monopod to ensure that the back of the camera is level (the camera is taking a photo straight down). Take a photo of the ground. View the photo. Make sure that your feet and the monopod are not part of the photo.

Walk down the transect, repeating the previous 4 steps every 10 feet. At the 10-ft, 50-ft, and 90-ft points, place a 9.6-ft^2 production hoop at the point before taking the photo. Make sure that the majority of the hoop is within the photo. These hoops will be used in the Grass Production method below after taking the photo.

Camera on a Stick analysis
Analyze the photos using SamplePoint software to determine the percent cover of each species and ground cover classification described above:

Organize the photos into folders by transect. Create a database in SamplePoint for the transect. Enter the species list for the transect in the database as buttons (or create button file). Include litter, rock, moss, lichen, cyanobacterial soil crust, and bare ground (which will be analyzed and reported with the data from Eg51 a-d). Analyze each photo using a 10 x 10 crosshair grid. After all the photos from the transect are analyzed, create statistics files to calculate average cover for each species/ground cover type.

The percent cover of each species is then reported and compared with future recordings on the same transect. If multiple transects are measured for a site, the average percent cover is calculated for each species and ground cover classification. The appropriate statistical analysis will be applied to the changes over time.

Locations: Key sites and exclosures within grass, sagebrush, mountain brush, aspen, and riparian communities. This network includes 30 monitoring sites across the LSSC geography; **Attachment 4** lists these sample locations by community type and geo-spatial coordinates.

Timing/Frequency: Mid-June for lower elevation sites, July for higher elevation sites desirable, but dependent on weather/snow melt. 2017 (baseline), 2020 and then every 3-5 years thereafter.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring

Eg12 a-e: Plant vigor.

Methodology (Non-Woody Plants): Plant vigor for non-woody plants will be assessed by measuring: grass and forb seedhead production, and grass production. Methods described here were designed specifically for the La Sal Sustainability Collaborative to measure if native herbaceous plants are producing seedheads (inflorescences), if those seedheads are being grazed off of the plants, and to estimate the rate of inflorescence production. This method will use a standard 9.6-ft^2 grass production hoop to delineate the sample areas along all 100-ft transects at a monitoring site. This method also includes collecting grass production data at 3 of the 10 seedhead production hoops.

<u>Grass Seedhead Production</u>***.*** Along each transect established at a site (see Transect Establishment), lay down a 9.6-ft^2 grass production hoop to the right of the 10 foot mark of the tape an inch or two away from the tape. Spread the hoop out so that it is as circular as possible. In the data sheet, record the species name of each <u>perennial</u> grass species that is rooted (or partially rooted) within the hoop. For each species, count the number of

individuals rooted within the hoop and record the number. Count the number of individuals of each species that have seedheads (or inflorescences) present (take note if it is simply too early for the plant to flower, if there are no inflorescences). Count the number of individuals of each species that have had all or part of their seedheads grazed off and record each of those numbers.

After all the species have been counted within a hoop, move on to the next 10-ft point and repeat the methods above. This will provide 10 samples of the seedhead production data at each transect.

Grass Seedhead Production analysis. This method allows for the calculation of individual species seedhead production, the percent seedhead production of all species, the percent seedhead production of groups of grasses, the percent of grasses with seedheads completely grazed off, and the percent of grasses with part of the seedheads grazed off (which can be broken down into species and groups as well). There are some grass species that do not show vigor by seedhead production (e.g. those species may reproduce by rhizomes or stolons or only produce seed when stressed). In this case, those species should be considered while analyzing seedhead production changes over time and the effects of management on those changes.

For the species that normally reproduce by seed, the total number of individuals, number of individuals with all seedheads, and the number of individuals that were partially and completely browsed are summed for each species. Divide the total number of individuals in a particular category above by the total number of individuals of that species and multiply by 100 to get the percentage of the individuals in that category. The appropriate statistical analysis will be applied to the changes over time.

Forb Seedhead Production***.*** Along each transect established at a site (see Transect Establishment), lay down a 9.6-ft^2 grass production hoop to the right of the 10 foot mark of the tape an inch or two away from the tape. Spread the hoop out so that it is as circular as possible. In the data sheet, record the species name of each herbaceous forb species that is rooted (or partially rooted) within the hoop. For each species, count the number of individuals rooted within the hoop and record the number. Count the number of individuals of each species that have all seedheads (or inflorescences) present (take note if it is simply too early for the plant to flower, if there are no inflorescences). Count the number of individuals of each species that have had all or part of their seedheads grazed off and record each of those numbers.

After all the species have been counted within a hoop, move on to the next 10-ft point and repeat the methods above. This will provide 10 samples of the seedhead production data at each transect.

Forb Seedhead Production analysis. This method allows for the calculation of individual forb species seedhead production, the percent seedhead production of all species, the percent seedhead production of groups of plants (perennial forbs, annual forbs), the percent of plants with seedheads completely grazed off, and the percent of plants with part of the seedheads grazed off (which can be broken down into species and groups as well).

The total number of individuals, number of individuals with all seedheads, and the number of individuals that were partially and completely browsed are summed for each species. Divide the total number of individuals in a particular category above by the total number of individuals of that species and multiply by 100 to get the percentage of the individuals in that category. The appropriate statistical analysis will be applied to the changes over time.

Grass Production (with a 9.6-ft^2 hoop). Identify all of the grass species within the first hoop (at 10-ft point along the transect). Locate representative samples of all of these species outside the hoop, and decide on a quantity of that species to use as a unit. Clip and weigh each unit in g. Estimate how many units of each species are rooted within the hoop. Clip and weigh the amount of each species that is rooted within the hoop. Divide the clipped weight by the estimated weight for each species to determine the correction factor. Evaluate the other 2 hoops (at 50-ft and 90-ft points along the transect) in the same manner, determining a unit and correction factor for any new species. Estimate the % of dry weight for each species using the NRCS Technical Note "Dry Weight Percentages of Selected Western Grasses, Grass-likes, Forbs, Vines, Shrubs, and Trees." Assign a reconstruction factor for each species, using your professional experience and taking into account the time of year and weather (e.g., if 80% of total annual growth has occurred, the reconstruction factor would be 0.8).

Grass production analysis
Calculate total production for each species (for a 9.6-ft^2 hoop):

$$\frac{\text{unit weight} * \text{average units per hoop} * \text{correction factor} * 10 * \text{\% of dry weight}}{\text{reconstruction factor}}$$

Add total production for each species together to calculate total grass production.

Locations:
Grass production: Key sites and exclosures within the grass, sagebrush, mountain brush, aspen and riparian communities. This network includes 30 monitoring sites across the LSSC geography; **Attachment 4** lists these sample locations by community type and geo-spatial coordinates.

Grass and forb seedhead production: Inside and outside each of the 7 exclosure sites.

Timing/Frequency:
Grass production:
Mid-June for lower elevation sites, July for higher elevation sites desirable, but dependent on weather/snow melt. 2017 (baseline), 2020 and then every 3-5 years thereafter.

Grass and forb seedhead production:

Post-grazing season, likely late August for lower sites and mid-late September for higher sites. 2017 (baseline), 2020 and then every 3-5 years thereafter – in years consistent with GIP monitoring.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring for grass production; Grand Canyon Trust for grass and forb seedhead production.

Methodology (Woody Plants): This method is an amalgamation of several methods used to determine size classes and leader browse for woody vegetation species. Although different size classes will be used for the various species, the same methods for data collection will be used for each species.

<u>Woody Species Density Belt Transect</u>
Along each transect established at a site (see Transect Establishment), walk down the transect holding a 6-ft (or 2m) pole (or PVC) pipe with a centerline marked on the pole that is maintained over the transect. Count all live woody key species that the pole intersects the base of the plant's stem (or passes under the pole), measure the height of each individual and record it in the data sheet under that size class (see size classes by species below). This method is a modification of the methods described in Herrick et al. (2009, p. 30), with the size classes by species, described below.

Size Classes by Species
Cottonwood and willow: There are seven size classes for these species which will be counted during the belt transect: 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, 4-5 ft, 5-6 ft, >6 ft.

Aspen: There are eight size classes for aspen which will be counted during the belt transect: 0-1 ft, 1-2 ft, 2-3 ft, 3-4 ft, 4-5 ft, 5-6 ft, >6 ft and DBH <1 inch, >6 ft and DBH >1 inch. This is a synthesis of size classes used by various groups and Jones et al. (2005), who suggests using the >6 ft and DBH >1 inch as the upper limit for elk and horse browsing, thus an indicator of long-term recruitment of aspen.

Sagebrush: There are four age classes for sagebrush which will be counted during the belt transect: seedling, young, mature, and decadent. The following are the classification parameters: seedling are plants up to 3 years old which have become firmly established, stems usually less than 1/8-inch diameter; young are plants larger with more complex branching, not showing signs of maturity, stems usually 1/8-1/4-inch diameter; mature are plants with complex branching, rounded growth form, seed is produced on healthy plants, stems usually larger than 1/4-inch diameter; decadent are plants, regardless of age, that are in a state of decline, usually evidenced by 25% or more dead branches.

Other Woody Species: Size classes are not recorded for other woody species.

Browsed leader measurements (for aspen, willow, cottonwood, and mountain mahogany)
For each individual counted within the belt, a 1-ft diameter hoop is held horizontally 6 inches below the top of the apical leader of the shrub or tree. Count and record every

leader that crosses through the hoop for the total number of leaders. Then count and record the number of leaders that have been browsed that cross through the hoop.

Browse measurements with standard woody palatable species density: When the density of palatable woody species being measured for browsed leaders is not excessive, as determined by the collaborative group establishing the transect, as you are walking down the transect with the 6-ft pole, stop at the 2-ft mark. With the pole perpendicular to the transect, measure the browsed leaders for the palatable woody individual closest to the transect that intersects with the pole using the following method:
Hold a 1-ft diameter hoop horizontally 6 inches below the top of the apical leader of the palatable shrub or tree. Count and record every leader that crosses through the hoop for the total number of leaders. Then count and record the number of leaders that have been browsed that cross through the hoop. Repeat the method every 2 feet along the transect.

Browse measurements with high palatable woody species density: If the density of the woody species is too dense to use the method above (e.g. areas with thick willow cover), establish either a 300-ft transect through the woody species being measured or three 100-ft transects through representative areas. The appropriate configuration of transects should be determined based on the woody species distribution in the riparian area. If the monitoring area is too small to accommodate 300 feet of transect, shorter transects may be used, but need to be documented.

Along the transect(s), where the palatable woody species being measured intercepts the transect, starting at the first even number on the transect, hold a 1-ft diameter hoop horizontally approximately centered over the even number of the transect and 6 inches below the apical leader of the palatable shrub or tree. Count and record every leader that crosses through the hoop for the total number of leaders. Then count and record the number of leaders that have been browsed that cross through the hoop. Repeat the method every 2 feet along the transect.

Analysis

Calculating plants/acre

Total each height/age class for each species, then multiply the number of plants in each class by 72.6 (if you used a 6-ft pole) or 66.385 (if you used a 2m pole) to get the number plants in each class/acre. This can be completed in the office. The appropriate statistical analysis will be applied to the changes over time.

Calculating browsed leader percentage

Total the number of leaders measured within each height class for each species, and the number of leaders browsed. Divide the number of browsed leaders by the total number of leaders and multiply by 100.

Locations:

Woody Species Density: Key sites and exclosures within the grass, sagebrush, mountain brush, aspen and riparian communities. This network includes 30 monitoring sites across the LSSC geography; **Attachment 4** lists these sample locations by community type and geo-spatial coordinates.

Browsed Leader Measurements: Key sites and exclosures where aspen, willow, cottonwood, and/or mountain mahogany are present.

Timing/Frequency:

Woody Species Density: Mid-June for lower elevation sites, July for higher elevation sites desirable, but dependent on weather/snow melt. 2017 (baseline), 2020, and then every 3-5 years thereafter.

Browsed Leader Measurements: Late September; 2017 (baseline), 2020, and then every 3-5 years thereafter – in years consistent with GIP monitoring.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring for woody species density; Grand Canyon Trust for browsed leader measurements.

Eg21: Miles of stream habitat occupied by self-sustaining populations of native fish assemblages.

Methods: Approximate 0.1 mile sections of stream will be sampled with backpack electrofishing gear. Block nets will be placed at both the downstream and upstream bounds to limit fish immigration and emigration. A minimum of two passes with electrofishing gear will be completed and collected fish will be held in live cages outside the study area. All fish collected will be enumerated and measured for total length and weight. Fish population size (# fish/mile) and 95% confidence intervals will be estimated using the Moran-Zippen (2 passes) or the Zippen method (> 2 passes). In some cases presence/absence surveys may only be necessary. Backpack electrofishing sites will vary in station length and catch may be reported as fish/h for these surveys.

Once native populations are sampled, miles of stream occupied can be estimated. Sampling information will be used to total up number of miles using mapping software (e.g., Google Earth, ArcMap, etc.)

Location: Those streams within the LSSC where we are actively trying to protect or restore native fish assemblages, including at least the following waterways:

- Deer Springs Creek
- La Sal Creek
- Beaver Creek

Investigate the potential for protecting or re-establishing self-sustaining populations of native fish in the following waterways:

- Pack Creek and upper Hell Canyon Creek
- Brumley Creek
- Kane Creek

Timing/Frequency: Survey work would be conducted in the August-September timeframe every 2-3 years.

Responsibility: Utah Division of Wildlife Resources

Water Quality and Water Quantity Measures (Eg31a-d and Eg32). Protocols for monitoring water quality and water quantity are adopted from those used by the State of Utah, Department of Environmental Quality, Division of Water Quality (UDWQ). It should be noted that all field parameters (Temperature, pH, Conductivity, Dissolved Oxygen and flow) are generally taken with water chemistry samples. Therefore, all field parameters will be collected in conjunction with the nutrient samples mentioned in a following indicator.

Initially water quality/quantity will be monitored in three streams: Beaver Creek, La Sal Creek, and Deer Springs Creek. In the future other water quality/quantity monitoring sites may be added based on the outcome of our investigation of the potential for protecting or re-establishing self-sustaining populations of native fish (e.g., Pack Creek/Upper Hell Canyon Creek, Brumley Creek, and Kane Creek).

Several factors drove identification of streams that will be monitored and selection of specific sample sites, including but not limited to: possibility for native fish reintroduction, quantity of water, diversions, accessibility, availability of historic water quality/quantity data, and whether a site can be used to evaluate upstream management practices. A description and map of the initial water quality/quantity sites selected follows.

<u>Deer Springs Creek</u> above diversion; Latitude: 38.36354° Longitude: 109.2159°. (WGS 1984 Datum) Although this site is not accessible by motor vehicle, it is not difficult to access with a ½ mile hike from the nearest road. It is the lowest point on the reach that consistently has water. There was some limited water quality monitoring performed at the site in 2015 and 2016.

<u>La Sal Creek</u> above the Forest Service Road 073 crossing and above the fish barrier; Latitude: 38.385157° Longitude: -109.208885°. (WGS 1984 Datum) Site is easily accessible by motor vehicle and has multiple years of DWQ and Forest Service historical water quality data. It is above any diversion.

<u>Beaver Creek</u> above where the Chicken Creek diversion crosses the stream; Latitude: 38.387682° Longitude: -109.168719°. (WGS 1984 Datum) The Forest Service installed a gauging station below the diversion and began collecting instream flows in 2015. This water quality monitoring site was established by UDAF in 2015.

Google Earth geospatial image of LSSC water quality and water quantity monitoring locations.

Eg31a: Water Temperature.

Methodology: Characterization of water temperature requires relatively continuous measurements throughout the productive season because temperature fluctuates seasonally and diurnally. If flow data are not also being collected, temperature will be monitored with a "hobo" meter appropriately secured below low flow water level. If flow is also required a pressure transducer will be deployed that will collect temperature and depth measurements. The instruments will be programed to collect temperature readings every 15 minutes. It is anticipated that the instrument will not need maintenance during deployment. Data collected by the instrument will be downloaded and the files will be stored by the Southeast Utah Watershed Coordinator and a copy will be sent to the Utah Department of Agriculture and Manti-La Sal National Forest. A complete copy of the Standard Operating Procedure for continuous monitoring with "hobos" or pressure transducers may be found in monitoring plan **Attachments 5.1 and 5.2** (UDWQ: Continuous Temperature Monitoring with Hobos and UDWQ: Continuous Pressure and Temperature Monitoring with Transducers).

Locations: Deer Springs Creek, La Sal Creek, and Beaver Creek (see geo-referenced sample locations above).

Timing/Frequency: Deployment in mid-May and retrieval late September, with measurements recorded every 15 minutes. Analysis will be conducted and reported annually.

Responsibility: The Southeast Utah Watershed Coordinator will be responsible for Deer Springs, and La Sal Creeks. The Manti-La Sal National Forest will be responsible for data collection in Beaver Creek.

Eg31b: Nutrients.

Methods: This indicator is easily collected using UDWQ protocols. After collection, the samples are sent to the State Utah Division of Laboratory Services for analysis. An agreement has been reached between the Utah Department of Agriculture and Food (UDAF) and UDWQ that UDWQ will provide necessary funding for monthly sample analysis for the water bodies identified below. Monthly samples will consist of both total and filtered samples. It is anticipated that these samples will be part of a more encompassing effort by UDWQ and UDAF to determine productivity in these streams. That effort also requires a week-long deployment of a dissolved oxygen logger for determination of productivity. Results will be compared to State Standards. A copy of the standard operating procedure for determining nutrient levels is included in monitoring plan **Attachment 5.3** (UDWQ Protocols for Nutrient and Water Chemistry Samples).

Locations: Deer Springs Creek, La Sal Creek, and Beaver Creek (see geo-referenced sample locations above).

Timing/Frequency: Samples will be collected monthly during the productive season, May through September. Analysis will be conducted and reported annually.

Responsibility: The Southeastern Utah Watershed Coordinator will be responsible for the monthly sampling.

Eg31c: Dissolved Oxygen.

Methods: Dissolved Oxygen (DO) and percent DO is a field measurement that can be measured with either an optical or electrochemical meter. Either methodology is easily collected using UDWQ protocols. Instantaneous or continuous monitoring results will be compared to State Standards. There are a variety of instruments available to collect these field parameters. Calibration of instruments will follow the manufacturer's recommendations. It is always recommended that dissolved oxygen be calibrated in the field as barometric pressure and altitude can affect its readings.

Dissolved oxygen varies diurnally. Although instantaneous measurements of DO are helpful, collecting DO with data loggers over several days provides a greater characterization of DO conditions. It is anticipated that mini DO_2T DISSOLVED OXYGEN

LOGGERs will be deployed for one to two weeks in August and scheduled to collect readings every 15 minutes. A complete copy of the Standard Operating Procedure for continuous monitoring of dissolved oxygen is included as monitoring plan **Attachment 5.4** (UDWQ: Standard Operating Procedure for MiniDO_2T Dissolved Oxygen Logger).

Location: Deer Springs Creek, La Sal Creek, and Beaver Creek (see geo-referenced sample locations above).

Timing/Frequency: Instantaneous field measurements that include DO will be collected with water quality samples monthly during the productive season, May through September.

Responsibility: The Southeast Utah Watershed Coordinator will be responsible for the monthly sampling and the Southeast Utah Watershed Coordinator and the Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring will share responsibility for deployment of DO loggers in August.

Eg31d: Macroinvertebrate Community Composition.

Methods: The purpose of this method is to collect and compare the macroinvertebrate communities to state reference conditions. UDWQ uses a model of observed species in a sample divided by expected species at reference sites of similar topography that are not anthropogenically influenced. The data are assessed based upon the percentage of expected species present. In general, streams containing 80% of expected species are considered supporting the expected biota and streams containing less than 70% of expected species are considered not supporting their expected biota. Samples are collected using the UDWQ protocol in monitoring plan **Attachment 5.5** (UDWQ: Standard Operating Procedure for Macroinvertebrate Collection). In brief, the collection technique consists of a semi-quantitative benthic macroinvertebrate composite sample using a D-frame net. A composite sample is performed by collecting 8 subsamples made at different locations within a stream reach that is established to characterize the habitat and several biotic assemblages associated with the stream. The sampler carries a sieve bucket as they move through the reach and composites the benthic material collected in the D-net at each subsample location into the sieve bucket. The collection technique is designed to be rapid so that one subsample requires no more than 3 minutes to perform. At each of the 8 subsample locations, the sampler attempts to collect all available benthic macroinvertebrates (BMI) located in a one square-foot area upstream of the D-net opening. BMI are collected from the largest substrates down to the smaller substrate to a depth of approximately 3 inches. The sampler rinses the material to the bottom of the net and then empties the contents of the net into the sieve bucket. The result is a composite BMI sample in the sieve bucket.

Sample processing is required for the composite sample because most of the heavy inorganic benthic material collected is not of interest and the BMI in the sample must be concentrated into small jars for transfer to the analytical laboratory. Processing involves using a regular 2.5 gallon bucket and water to separate out heavy inorganic material from lighter organic material (where the BMI are most likely located). This separation process results in a much smaller volume of material which is then placed into 1 L plastic jars and preserved with 95% ethanol. Jars are then sealed, labeled, and stored until delivery to the laboratory. Samples are sent to the inter-agency bug lab at Utah State University. Results and assessment are administered by UDWQ.

Location: Deer Springs Creek, La Sal Creek, and Beaver Creek (see geo-referenced sample locations above).

Timing/Frequency: Samples are collected once per year in August or September for three years and every three years after that.

Responsibility: The Southeast Utah Watershed Coordinator and Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring

Eg32: Summer base flows above the first point of diversion (indexed to precipitation).

Methods: Pressure transducers are secured in stilling wells above the first stream diversion and programed to collect a water depth measurement in the stilling well every 15 minutes as documented in the UDWQ protocols included as monitoring plan **Attachment 5.6** (UDWQ: Pressure Transducer Standard Operating Procedure). After several flow measurements at different flows are collected a "stage discharge rating curve" can be constructed to define the relationship of transducer provided depth measurements to flow volume.

Baseflow Index: the indexed baseflow is computed by multiplying the summer baseflow rate by the precipitation index; both as follows.

Summer base flow: this volumetric flow rate (cubic feet per second) is computed by taking the arithmetic average of all 15-minute measurements taken between midnight on July 1st and midnight on September 30th. It can also be computed by taking the average of the two mean monthly flow rates, or the average of the mean daily flow rates for the same period.

Precipitation index: long-term (>20 years) precipitation data taken at a nearby (<10 miles) weather station are needed to create an annual precipitation index. The La Sal Station #572 be used for this purpose. The precipitation index is calculated as the total annual precipitation (inches) [summed from October 1st through September 30th of the following year] divided by average total annual precipitation (inches) [taken for the period of record]. This gives a dimensionless ratio centered around unity ('1.00'); with values less than 1.00 indicating "dry" years and values greater than 1.00 indicating "wet" years.

For Example: If the average annual precipitation measured at the La Sal Station is 30.47 inches/year for the period 1980-2015, and in 2012, a total of 20.10 inches of precipitation were measured, that would yield an index of *0.66*. In comparison if in 2015, the annual precipitation total was 29.60 inches, the index would be *0.97*.

Location: Deer Springs Creek, La Sal Creek, and Beaver Creek (see geo-referenced sample locations above).

Timing/Frequency: Deployment in mid-May through September 30, with retrieval in early October. Measurements recorded every 15 minutes. Analysis will be conducted and reported annually.

Responsibility: The Southeastern Utah Watershed Coordinator will be responsible for Deer Springs, and La Sal Creek. The Manti-La Sal National Forest will be responsible for data collection in Beaver Creek and indexing of flows to precipitation for all three streams.

Eg33a: Riparian acres/condition.[1]

Methods: Methodology developed at Utah State University (Wheaton and Bouwes, 2009) will be used to track trends in amount and condition of riparian areas at the landscape scale. Two assessment processes (i.e., Riparian Vegetation Condition Assessment and Riparian Conversion Assessment) – which have been automated and converted into an ArcGIS tool – will be used in tandem to provide a more complete and explicative product for use in assessing riparian area condition.

Riparian Vegetation Condition Assessment (RVCA). RVCA uses LANDFIRE Existing Vegetation Type (EVT) and Biophysical Settings (BpS) data to estimate riparian vegetation change since Euro-American settlement at a reach level (200 – 500 m segments). The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. The BpS layer is used as a proxy for the reference (pre-settlement) vegetation condition and the EVT layer is used to represent the current vegetation condition. The vegetation condition assessment is accomplished by coding native riparian vegetation as a 1 and non-native riparian and upland classes as a 0. In addition, within large rivers, the open water class is coded as “no data” and outside of large rivers open water was coded as a 1. This coding was determined through test runs of the assessment that found that if all open water was classified as a 1 it skewed large river conditions to appear to be in better shape than they really are and if all open water was classified as “no data” it skewed the smaller river riparian areas to appear to be in worse shape than they really are. The following equation is used to calculate a dimensionless ratio:

[1] Note: Systems in the Southern La Sal's and adjoining canyon lands within the area of our collaboration are generally small/narrow. We anticipate that at a landscape level we may only be able to detect changes in riparian area and condition in those areas where we successfully reintroduce beaver into those systems.

(mean EVT vegetation value)/(mean BpS vegetation value)

The closer the value is to zero, the more degraded the riparian vegetation condition is compared to the pre-settlement condition. Values larger than 1 show areas that have increased in native riparian vegetation since settlement.

Riparian Conversion Assessment (RCA). RCA is a supplement to the RVCA method and provides information to explain what might be causing riparian degradation along the stream network. Like RVCA, RCA uses LANDFIRE EVT and BpS data. The BpS riparian vegetation is coded as 1 and all other vegetation types are coded as a 0. The EVT vegetation types are given codes from 1 to 17 using only odd numbers. This information can be tallied to provide an estimate of total acres of riparian area, and further parsed into total acres of native and invasive riparian area.

Overlaying the two layers provides a new layer with values 1 to 18, where even numbers represented conversions related to historic riparian vegetation cover. Each segment of valley bottom is categorized based on the conversion type for the majority of riparian conversion related pixels within the segment. The output of this process displays the most prevalent cause of riparian conversion within each given segment.

A detailed description of these assessments will be published in a peer-reviewed scientific journal within the next year. However, a detailed working description of the methodology is included as **Attachment 6** to this monitoring plan.

Location: Assessment of riparian area/condition will be done for the entire LSSC landscape.

Timing/Frequency: A completed riparian vegetation condition assessment using these methodologies[1] for the Colorado Plateau, based on Landfire EVT information using 2012 aerial photography will be used to establish a baseline. Landfire is updated every two years in the spring with two year old data. Re-assessment, for the purposes of the LSSC will be performed approximately once every 6-10 years to estimate trends in conditions.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program, working in partnership with Utah State University.

Streambank and Instream Conditions (*Eg33b-f).* Protocols for monitoring streambank and instream conditions are adapted from BLM Technical Reference 1737-23, 2011, available at http://www.blm.gov/techreferences. A sample data sheet is included as monitoring plan **Attachment 7**. Guidelines for selection of areas to monitor streambank and instream conditions and specific sample reach locations are included as monitoring plan **Attachment 8**.

Certain general data collection considerations apply to all of the streambank and instream indicators, specifically:

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[1] **http://etal.usu.edu/Colorado_Plateau_Ecoregion/03_Riparian_Vegetation_Condition_Assessment/**

1) Most measurements will be taken using the "greenline" as a reference. The greenline is defined as the "first perennial vegetation that forms a lineal grouping of community types on or near the water's edge." It may sometimes consist of embedded rock or anchored wood instead of a band of vegetation. Identify the greenline on each side of the stream and estimate the average distance from the greenline on one side of the stream to the greenline on the opposite side of the stream (greenline-to-greenline width) within the segment of the stream where monitoring will take place. Ideally, a species list of the plants present along the greenline should be compiled before monitoring begins.

2) Select a monitoring area (DMA, or designated monitoring area) that includes a representative section of the stream susceptible to impacts from land management activities that is at least 110 m (361 feet) long. It should span at least two meander lengths and be approximately 20 times longer than the average greenline-to-greenline width. For example, a monitoring area covering a 142 m long section of stream is appropriate when the greenline-to-greenline width averages 7.1 m.

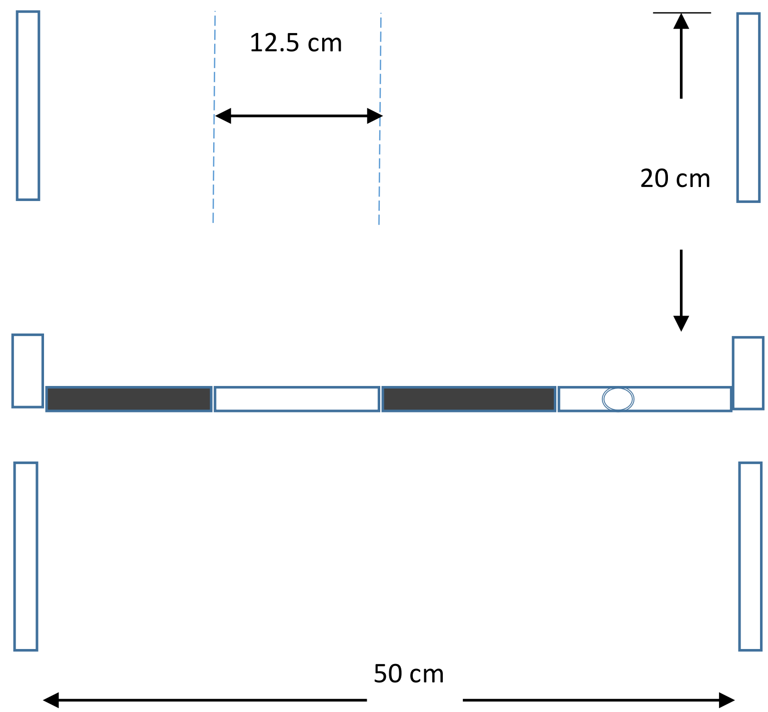
3) Mark the downstream and upstream ends of the monitoring area with permanent markers, such as bent or capped rebar. Place a marker on the left side of the stream (facing upstream) at the downstream end and another marker on the right side of the stream at the upstream end. The markers should be ≥ 2 m from the top of the stream bank to minimize the chance of them washing out during periods of high stream discharge. Use a GPS unit to record the latitude and longitude (in decimal degrees) or UTM coordinates of each marker. Take four photos from the following perspectives: (1) looking upstream from the downstream marker, (2) looking across the stream to the opposite bank from the downstream marker, (3) looking downstream from the upstream marker, and (4) looking across the stream from the upstream marker. Record filenames of each photo in the appropriate fields in Part 1 of the datasheet.

4) Select a reference point (prominent and permanent feature in the monitoring area) or place a reference marker in a prominent location for use in locating the monitoring area in the future. Use a GPS unit to record the latitude and longitude (in decimal degrees) or UTM coordinates of the reference point/marker.

5) Measurements of streambank alteration and vegetation will be obtained using a 50 cm long monitoring frame with a center bar and two bars projecting 20 cm on each side from each end of the center bar (*see illustration of monitoring frame on the following page).* The monitoring frame functions as two side-by-side Daubenmire quadrats.

   The center bar of the monitoring frame will be aligned with the greenline during sampling on each side of the stream. The sampling interval, or distance between plot locations along the greenline, should result in 40 plot locations on each side of the stream. Divide the length of stream in the monitoring area by 40 to determine the appropriate sample interval (e.g., 2.75 m for a 110 m long monitoring area). Record this value under "Sample Interval" in Part 1 of the datasheet.

Illustration of frame to monitor streambank alteration and vegetation.



6) Estimate the overall gradient (percent grade) of the stream channel from the center of the upstream end of the monitoring area to the center of the downstream end of the monitoring area. This may be done on a coarse scale using GIS mapping and analysis, or may be estimated using a clinometer and tape measure or range finder. The clinometer method usually requires two observers: one with the clinometer at the upstream end and another located at the downstream end and holding a sighting target positioned at a height that corresponds to the distance from the ground to the eye level of the observer using the clinometer. Multiple measurements will usually be required unless there is a straight and unobscured line of sight following the stream channel from one end of the monitoring area to the other. An alternative method for on-site estimation of the stream gradient is to obtain precise GPS readings of elevation, using a survey grade GPS unit, at the upstream and downstream ends of the stream channel and divide the difference in elevation by the length of the stream channel.

Eg33b-c: Streambank conditions (i.e., mechanical trampling/shearing, occurrence of deeply rooted vegetation).

Methods:

Streambank Condition. Use the monitoring frame to measure streambank condition. To determine the location of the first plot, randomly pick a number between 1 and 10 and take that number of steps up the stream channel from the downstream end of the monitoring area. Turn and move perpendicularly to the greenline on the left bank and place the monitoring frame there with the center bar oriented along the greenline. Record the number of cross-plot lines (perpendicular bars at the ends of the frame and three imaginary lines between them spaced 12.5 cm apart) that intersect mechanical trampling or shearing of the streambank. This value will range from 0 to 5. Use a 2 m long measuring rod to measure the distance to the next plot. Repeat until measurements have been recorded for the 40 plots within the DMA.

Analysis of Streambank Condition: Add the numerical values from each plot; divide sum by 200 to derive a percentage of the streambank with mechanical trampling or shearing.

Greenline Composition. Use the monitoring frame to measure greenline cover, species composition, and information on woody plant species in each plot. With the monitoring frame positioned along the greenline, estimate the percent cover for all herbaceous plant species rooted in the plot. (See pages 40-42 of BLM MIM of Stream Channels and Streamside Vegetation 2011, Technical Reference 1737-23). If no cover of any kind is present, record NG. This effort should be synchronized with the assessment of streambank condition described above.

After all understory cover has been accounted for, list the woody plant species (if any) that make up the overstory vegetation. The tally of overstory plant species should include the trees or shrubs that are rooted in and any others that have limbs extending over the monitoring frame. Do not attempt to estimate relative cover.

Analysis of Greenline Composition: Add the estimated percent herbaceous cover from each plot and divide that percentage by 40 to derive an estimate of the total percent herbaceous cover along the greenline. Next, tally the percent cover from each plot of herbaceous species that are deeply rooted (**Attachment 9**) and divide that sum by 40 to derive an estimate of the total percent of greenline with deeply rooted herbaceous species. Finally, add the number of plots with one or more woody species rooted in or overhanging the plot, and divide the sum by 40 to derive an estimate of the total percent of greenline with a woody overstory. Next, tally the percent overstory from each plot of woody species that are deeply rooted (**Attachment 9**) and divide that sum by 40 to derive an estimate of the total percent of greenline with a deeply rooted woody overstory.

Location: Sample reaches will be established on

- Deer Springs Creek
- La Sal Creek
- Beaver Creek

- Three Mile
- Cottonwood Creek
- Muleshoe Creek
- West Coyote Creek
- Trout Water

Specific information on location of sample reaches for these streams may be found in **Attachment 8.**

Timing/Frequency: Late summer or early fall (after runoff and any grazing that occurs)/Once every 3-5 years

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring, with assistance from agency personnel and the Southeastern Utah Watershed Coordinator.

Eg33d-f: Instream conditions (i.e., pool length/depth, sedimentation of substrate).

Methods:
<u>Pool Length and Depth</u> – Start at the downstream end of the monitoring area and identify the first riffle crest (downstream edge of the first pool that is at least half the wetted width of the stream. Measure the thalweg depth at the riffle crest using a meter stick or measuring rod marked at 1 cm intervals. Use a tape measure or laser range finder to measure the distance from the riffle crest to the deepest part of the pool. Record the depth and measure the distance from the deepest point of the pool to the closest upstream riffle crest. Repeat this process until all pools in the survey area that are at least half the wetted width of the stream have been measured (see pages 64-66 of BLM Technical Reference 1737-23, 2011 for details).

Analysis of Pool Length and Depth. Sum pool lengths for the DMA and divide by the total length of the DMA to determine a % stream length with pools at least half the wetted average width of the stream. Sum maximum pool depths and divide by the total number of pools sampled to determine average maximum pool depth.

<u>Streambed Substrate</u> – Stream substrate measurements should be obtained from transects extending across the streambed that are aligned with even numbered plots (see Part 3 of the datasheet in **Attachment 7**). Along each of these transects measure the width of 10 “pebbles” located at uniformly spaced points in the stream channel. Divide the width of the active channel by 10 to determine the appropriate pebble sampling interval. Start at half the distance of the sampling interval from the bank and work toward the opposite bank. For example, if the streambed is 4 m wide, the sampling interval is 0.4 m and the first measurement will be obtained at 0.2 m (20 cm) from the scour line. A tape measure can be strung over the transect to facilitate this process. At each sample point, the observer should (without looking) place an index finger or wire pin flag on the substrate in the streambed directly below the sample point. Measure the diameter (region of greatest

dimension) of the particle of substrate touched by the finger or pin flag. A ruler or sampling template ("gravelometer") may be used for this purpose (see pages 62-63 of BLM Technical Reference 1737-23, 2011 for details). If the substrate is too small to measure, record it as "sand/silt."

Analysis of Streambed Substrate. Tally the number of particles recorded as "sand" or "silt" and divide the sum by 200 to estimate the percent of streambed covered in sand or silt.

Location: Sample reaches will be established on

- Deer Springs Creek
- La Sal Creek
- Beaver Creek
- Three Mile
- Cottonwood Creek
- Muleshoe Creek
- West Coyote Creek
- Trout Water

Specific information on sample reach locations for these streams may be found in **Attachment 8**.

Timing/Frequency: Late summer or early fall (after runoff and any grazing that occurs); once every 3-5 years.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring, with assistance from agency personnel and the Southeastern Utah Watershed Coordinator.

Eg33g: Macroinvertebrate Community Composition.

Methods: See Eg31d above.

Location: See Eg31d above.

Timing/Frequency: See Eg31d above.

Responsibility: See Eg31d above.

Eg34: Number of springs protected.

Methods: Spring sources and their associated wetlands are protected from impacts while providing controlled, off-site drinking water for domestic ungulates and wildlife (subject to valid existing rights), as determined by LSSC members in consultation with the relevant land management agency.

Location: Where they occur on the landscape.

Timing/Frequency: Assessed at the semi-annual meetings of the LSSC.

Responsibility: LSSC members and agency advisors.

Eg41: Fuel Loading

Methods: Fire Regime Condition Class or Vegetation Condition Class (VCC) will be used as a surrogate of "fuel loading" within the LSSC geographic area and tracked using remotely sensed information. VCC represents a simple categorization of the associated Vegetation Departure (VDEP) layer and indicates the general level to which current vegetation is different from the simulated historical vegetation reference conditions. VDEP is based on changes to species composition, structural stage, and canopy closure. The calculated VDEP metric for relatively homogenous vegetated areas ranges from 0 – 100.

Currently six condition classes are represented:

VCC 1a: Very Low, VDEP = 0-16

VCC 1b: Low, VDEP = 17-33

VCC IIa: Moderate to Low, VDEP = 34-50

VCC IIb: Moderate to High, VDEP = 51-66

VCC IIIa: High, VDEP = 67-83

VCC IIIb: Very High, VDEP = 84-1000

Beginning with Landfire 2012 data, the percent area of the LSSC landscape within each of the six condition classes will be calculated. The percent by condition class will be recalculated with each subsequent Landfire analysis and trends tracked over time. Success will be indicated by decreasing trends for percent of the landscape in VCC IIb, VCC IIIa, and VCC IIb and increasing trends in the percent of the landscape in VCC IIa, VCC Ib, and VCC Ia.

VCC and VDEP are described in greater detail at:
http://www.landfire.gov/NationalProductDescriptions11.php.

Location: LSSC wide

Timing/Frequency: Ongoing/every-other year (based on Landfire data availability).

Responsibility: Forest Service

Eg42: Burn Severity

Methods: Burn severity will be assessed for fires greater than 500 acres as determined using the Burned Area Reflectance Classification (BARC) methodology, see **Attachment 10**.

The intention is to document acres burned at severe intensity each year and track trends over time.   A baseline for burn severity can be calculated for the LSSC geography using existing data from 2000-2015.

Location: LSSC wide

Timing/Frequency: Ongoing/annual

Responsibility: Forest Service, Bureau of Land Management, and State Lands

Eg43: Sediment Delivered

Methods: Estimated cubic yards of sediment/square mile delivered to stream channels will be assessed for fires greater than 500 acres as determined using the Erosion Risk Management Tool (ERMiT). This tool allows users to predict the probability of a given amount of sediment delivery from the base of a hillslope following variable burns on forest, grassland, and chaparral conditions in each of five years following wildfire. The tool may be accessed at http://forest.moscowfsl.wsu.edu/fswepp/. The intention is to document estimated cubic yards of sediment/square mile delivered to stream channels within the LSSC geography each year and track trends over time. A baseline for sediment delivered to stream channels can be calculated for the LSSC geography using existing data from 2000-2015.

Location: LSSC wide

Timing/Frequency: Ongoing/annual

Responsibility: Forest Service

Eg44: TES Habitat Impacted

Methods: Estimated acres of threatened/endangered/sensitive species habitat adversely impacted will be assessed for fires greater than 500 acres. The intention is to document acres of TES habitat adversely impacted by wildfire each year and track trends over time.

Location: LSSC wide

Timing/Frequency: Ongoing/annual

Responsibility: Forest Service, Bureau of Land Management, and State Lands**.**

Eg51a-d: Ground cover *(to help inform conclusions about whether soils are "improving")*

Methodology: The purpose of this method is to collect and measure changes in ground cover over time. These data will be collected with that for indicators Eg11a-e.

Transect Establishment and Line-point Intercept Method
All transects and line-point intercept methods should be the same as those used for Eg 11a-e. The following are modifications of the Herrick et al. (2009, p. 9) methods for ground cover measurements:

If there is litter obstructing the soil surface, include the litter as the lowest lower layer and the soil as the soil surface layer. If the pin lands in the base of a grass that is mixed with leaf litter, include the litter as one of the lower layers, but record the grass species as the soil surface layer. Leave any layer blank that does not have species intersect with it. If a pin lands on bare ground, rock, or biotic soil crust and doesn't intersect a plant species, simply include the ground cover as the soil surface layer. Any material that is not actively growing, but is from the current growing season (has entered into dormancy) is recorded as living material, so don't count this as litter (i.e., standing dead plant material will be recorded as "standing dead," along with its species name if it can be identified.). If a dead leaf from a previous growing season intersects the pin, record this as litter. Ground cover classifications include: litter (herbaceous), embedded litter (both woody and herbaceous), woody debris, manure, bedrock, rock (>5 mm diameter), moss, lichen, cyanobacterial soil crust, and bare soil. Litter is defined as dead plant material that is in contact with the soil surface. The species of origin of manure is recorded in the site notes.

Analysis
To calculate the soil cover classes, count each of the 100 points that had the following bare soil categories present: soil with litter and vegetation canopy cover over it, soil with just litter over it and no vegetation canopy, basal cover by plant species, moss and/or lichen cover, bare soil with vegetation canopy cover and no litter cover, and bare soil without litter or vegetation canopy cover over it.

The cover for the classifications described in the previous paragraph are then reported and compared with future recordings on the same transect. If multiple transects are measured for a site, these cover classes are calculated for all transects on the site. The appropriate statistical analysis will be applied to the changes over time.

Locations: Key sites and exclosures within the grass, sagebrush, mountain brush, aspen and riparian communities. This network includes 30 monitoring sites across the LSSC geography; **Attachment 4** lists these sample locations by community type and geo-spatial coordinates.

Timing/Frequency: Mid-June for lower elevation sites, July for higher elevation sites desirable, but dependent on weather/snow melt. 2017 (baseline), 2020 and then every 3-5 years thereafter.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring.

Eg51e: Percent area with active soil erosion or pedestaling.

Methodology: This method is designed to identify the effects of management changes on soil erosion in both key areas and exclosures. It includes using line-point intercept to measure the extent of active erosion indicators over time.

<u>Transect Establishment</u>
All transects should be the same transects described in Eg11a-e.

<u>Erosion Line-point Intercept</u>
The erosion line-point intercept data are collected using the method described in Issue 1a: Native Plant Species Composition, except species and ground cover data are not collected at different vegetation layers. Instead, collect which of the following erosion features, taken from BLM (2005), intersects where the pin drops for each of the 100 points:

- Hummock – A small knoll or rounded mound that is usually vegetated in a meadow or wet area, that results from trampling or soil compaction.
- Pedestal - Plants or rocks that appear elevated as a result of soil loss by wind or water erosion (does not include plant or rock elevation as a result of non-erosional processes such as frost heaving).
- Terracette - “Benches” of soil deposition behind obstacles caused by water erosion.
- Rill - A small, intermittent water course with steep sides, usually only several centimeters deep. Rills generally are linear erosion features. For the purpose of this project, a rill will be no deeper than 1 foot.
- Gully - A furrow, channel, or miniature valley, usually with steep sides through which water commonly flows during and immediately after rains or snowmelt. Small channels eroded by concentrated water flow. For the purpose of this project, a gully will be deeper than 1 foot.
- Soil Depositional Area – Pile of loose soil particles that have been deposited by either wind or water erosion against one surface of vegetation, rocks or other features.

After the erosion feature has been identified at each point, measure the height (hummock, pedestal, terracette, soil deposition area) or depth (rill or gully) of the erosion feature compared to the nearest non-eroded interspace. In the case of large gullies, measure the depth of the gully at the point of pin drop to the edge of the gully.

Collect the species or ground cover at the point (species of vegetation, bare soil, litter, rock, pavement, biotic soil crust, moss).

<u>Analysis</u>
To calculate the percent cover of each erosion feature, count each of the 100 points that had the erosion feature present (top layer or one of the lower layers). This number is the percent cover of the erosion feature. The average height or depth of each feature will be calculated for each transect and site.

The percent cover of each erosion feature is then reported and compared with future recordings on the same transect. If multiple transects are measured for a site, the average percent cover is calculated for each erosion feature and ground cover classification. The appropriate statistical analysis will be applied to the changes over time.

Locations: Key sites and exclosures within the grass, sagebrush, mountain brush, aspen and riparian communities. This network includes 30 monitoring sites across the LSSC geography; **Attachment 4** lists these sample locations by community type and geo-spatial coordinates.

If there are areas of active erosion or pedestaling within the allotment, but which do not happen to be located at the transect sites, these areas should be noted for LSSC discussion and potential monitoring.

Timing/Frequency: Mid-June for lower elevation sites, July for higher elevation sites desirable, but dependent on weather/snow melt. 2017 (baseline), 2020 and then every 3-5 years thereafter.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring.

Eg51f: Soil Stability.

Methodology: Soil surface stability will be evaluated to determine the baseline condition of soils, to validate information collected by the federal agencies, and to understand how changes in grazing management may affect the soil surface in the future. This method is described in detail by Herrick et al. (2009, p. 23).

<u>Soil Stability</u>
Collect 18 soil surface samples (2-3 mm thick and 6-8 mm in diameter) at randomly chosen locations along one of the 100-ft transects established for Eg11a-e. Record the dominant cover class at each location (perennial grass, perennial forb, shrub, tree, or no cover). Place each sample in a sieve in a cell of a dry soil stability kit box. Fill each cell of the second box with deionized or distilled water.

Lower the first sieve from the dry box into the respective water-filled cell of the second box, taking 1 second to lower it to the bottom of the box. Start a stopwatch when the first soil sample touches the water. Continue adding one sample to the water every 15 seconds. Observe the samples from the time they hit the water to 5 minutes (300 seconds).

Raise each sieve completely out of the water and lower it to the bottom without touching the bottom of the box, taking 1 second to raise it and 1 second to lower it. Repeat this a total of 5 times. Rate the stability class for each sample based on the following:

Stability Class	**Criteria**
1	50% of structural integrity lost (melts) within 5 seconds of immersion in water, **OR** soil too unstable to sample (falls through sieve).
2	50% of structural integrity lost (melts) 5-30 seconds after immersion in water.
3	50% of structural integrity lost (melts) 30-300 seconds after immersion in water, **OR** <10% of soil remains on the sieve after 5 dipping cycles.
4	10-25% of soil remains on the sieve after 5 dipping cycles.
5	25-75% of soil remains on the sieve after 5 dipping cycles.
6	75-100% of soil remains on the sieve after 5 dipping cycles, **OR** sample is hydrophobic (floats in water after pushed under).

Soil Stability analysis

Calculate the average stability rating for all samples by adding all of the stability values and dividing by 18. Calculate the average stability for protected or unprotected soils by adding the stability values for samples that were protected by plant canopy or had no canopy cover, respectively, and dividing by the total number of samples with those classifications.

Locations: Key sites and exclosures within the grass, sagebrush, mountain brush, aspen and riparian communities. This network includes 30 monitoring sites across the LSSC geography; **Attachment 4** lists these sample locations by community type and geo-spatial coordinates.

Timing/Frequency: Mid-June for lower elevation sites, July for higher elevation sites desirable, but dependent on weather/snow melt. 2017 (baseline), and then at the discretion of the LSSC.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring.

Eg52a: Percent occurrence of undesirable[1] species.

Methodology: This method uses the line-point intersect method described in Eg 11a-e, but calculates the percent cover of undesirable species. When a state-listed noxious weed is present, use the line-intercept and weed density belt transect methods, similar to methods described in USDA (1999) and Herrick et al. (2009, p. 9), respectively.

<u>Undesirable Line-point Intercept</u>

Using the method described in Eg 11a-e, all plant species cover will be collected, including invasive species.

Undesirable line-point intercept analysis

[1] Undesirable plant species are defined as invasive non-native, increasers that are indicative of poor management, noxious weeds, and other select species. A list of undesirable species is included as **Attachment K**.

The data from Eg 11a-e will be used to tease out the invasive species and noxious weeds present, as well as calculate the percent cover of each of those species. The change in the percent cover of invasive species will be compared over time.

Noxious Weed Line-intercept Cover
Walk along the transect established for line-point intercept, looking straight down on the measuring tape, and record the length (in) of the noxious weed plants that intercept the line, above or below the tape. Repeat this for every transect on a site.

Noxious weed line-intercept analysis
Calculate total percent cover by dividing the total length of weed plant transect by the total length of the transect. The appropriate statistical analysis will be applied to the changes over time.

Noxious Weed Belt Transect
Walk along the right side of the transect holding a 1-m section of PVC perpendicular to the transect tape. Count and record the number noxious weed plants that are rooted under the PVC by species every 10 feet along the belt until you have counted all noxious weed plants along the right side of the transect. Do this for all transects on the site.

Noxious weed belt transect analysis
Calculate the number of noxious weeds per square meter by dividing the total number of plants of each species by 30.48 (the number of square meters in the belt transects for a 100-ft transect). The appropriate statistical analysis will be applied to the changes over time.

Locations: Selected key sites and exclosures within the grass, sagebrush, mountain brush, aspen and riparian communities. This network includes 30 monitoring sites across the LSSC geography; **Attachment 4** lists these sample locations by community type and geo-spatial coordinates.

Timing/Frequency: Mid-June for lower elevation sites, July for higher elevation sites desirable, but dependent on weather/snow melt. 2017 (baseline), 2020 and then every 3-5 years thereafter.

Responsibility: Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring.

Eg52b: Area dominated by invasive species.

Methodology: All partners in the LSSC will be encouraged to map weeds with either an internal system for weed mapping or use EDDMapS. Interested stakeholders will be able to notify the LSSC of locations of concern for potential mapping or use the methods noted below for providing maps to the FS, BLM, and LSSC. Two options are described:

Using EDDMapS

If an LSSC partner chooses to use EDDMapS as a means to map weed populations, they can download the EDDMapS West mobile device app from either the Google Play Store (https://play.google.com/store/apps/details?id=com.bugwood.mrwc&hl=en) for an Android device or from the Apple Store (https://itunes.apple.com/us/app/eddmaps-west/id481009243?mt=8) for an iPhone. The user will need to set up an account with EDDMapS, which can be done either through the mobile app or on www.eddmaps.org. When an invasive species is identified, the person can map the weed population. It is essential to estimate the weed population size, even if it is a ball park estimate. If the population is small enough, EDDMapS West now allows you to walk around the perimeter of the population to map it.

If a person would prefer to map weeds and enter them on the EDDMapS system, but not use the mobile device to do so, he or she can map the weed, identify the size and species in their own system in either a notebook or in the name of the waypoint taken on the GPS. Then they can enter the data into their account on www.eddmaps.org. EDDMapS provides instructions for reporting sightings at http://www.eddmaps.org/about/step_by_step.cfm.

Other Mapping Systems

If an LSSC partner either prefers or is required to use another system for weed mapping, shapefiles of weed point or polygon locations can be sent to the Utah Department of Agriculture and Food (UDAF) monitoring staff, where they can prepare the data to be imported en masse into the EDDMapS database. For a mass data import, the following data fields need to be included in the attribute data of shapefiles submitted to the UDAF monitoring staff for each point in the data layer:

- Weed common name
- Weed scientific name
- Date of weed identification
- Name of person who identified the weed
- Estimated area of infestation in acres
- Estimated weed density or cover (optional)

Reporting

Annually, UDAF staff will provide maps to the LSSC of the invasive species of interest and highlight changes in weed populations (or changes in the mapping of weeds) over time.

Location: LSSC Landscape

Timing/Frequency: Ongoing/Assess changes every 3-5 years

Responsibility: Collection – all; Mapping, Assessment, Reporting -- Utah Department of Agriculture and Food, Grazing Improvement Program Monitoring

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UDWQ: Continuous Pressure and Temperature Monitoring with Transducers (Attachment 5.1)

UDWQ: Continuous Temperature Monitoring with Hobos (Attachment 5.2)

UDWQ: Pressure Transducer Standard Operating Procedure (Attachment 5.6)

UDWQ: Protocols for Nutrient and Water Chemistry Samples (Attachment 5.3)

UDWQ: Standard Operating Procedure for MiniDO$_2$T Dissolved Oxygen Logger (Attachment 5.4)

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LSSC Monitoring Plan, Appendix I Attachment 1: Template for tracking producer costs[1] of management.

Cost Category	**Cost/Year** (1000's of dollars)								
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**...**
LA SAL LIVESTOCK										
Permit										
Feed										
Animal Health and Reproduction										
Hired Labor										
Marketing and Associated Transportation										
Facility and Equipment Acquisition										
Fuel and Maintenance										
Taxes and Insurance										
Other Overhead										
Subtotal										
Adjustment for inflation from 2017 (±%)	0.000									
Total inflation adjusted producer costs										

The average of 2014-2015-2016 producer costs will be used as baseline.

[1] Some of these costs are proprietary.

Cost Category	Cost/Year (1000's of dollars)									
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**...**
BLT CATTLE										
Permit										
Feed										
Animal Health and Reproduction										
Hired Labor										
Marketing and Associated Transportation										
Facility and Equipment Acquisition										
Fuel and Maintenance										
Taxes and Insurance										
Other Overhead										
Subtotal										
Adjustment for inflation from 2017 (±%)	0.000									
Total inflation adjusted producer costs										

The average of 2014-2015-2016 producer costs will be used as baseline.

UGIP FY17 Draft Cost Share List							
Line Number	**Practice Code**	**Practice Name**	**Component**	**Unit Type**	**Full Price**	**GIP 50%**	**GIP 75% Public Land**
1	314	Brush Management	Biological - Livestock ($10,000 maximum payment)	HEAD/DAY	$1.00	$0.50	$0.75
2	314	Brush Management	Chaining - Single Pass, green trees, easy terrain	AC	$60.00	$30.00	$45.00
3	314	Brush Management	Chaining - Single Pass, green trees, difficult terrain	AC	$80.00	$40.00	$60.00
4	314	Brush Management	Chaining - Single Pass, sagebrush or after fire	AC	$45.00	$22.50	$33.75
5	314	Brush Management	Chemical - High - Tebuthiron $12/lb., 4 lbs./ac or similar cost chemical	AC	$24.00	$12.00	$18.00
6	314	Brush Management	Chemical - Low - Dicamba $80/gal., 1 pt./ac; or Glyphosate $40/gal. - 1 qt/ac; or Tebuthiron $8/lb., 1.25 lbs./ac, or similar cost chemical	AC	$13.85	$6.93	$10.39
7	314	Brush Management	Chemical - Medium - Tebuthiron $10/lb., 1.6 lbs./ac or	AC	$19.85	$9.93	$14.89

			similar cost chemical				
8	314	Brush Management	Chemical - Medium High - Glyphosate $80/gal. - 1 qt/ac or similar cost chemical	AC	$23.85	$11.93	$17.89
9	314	Brush Management	Chemical - Medium Low - Picloram $110/ga. - 1 pt./ac or similar cost chemical	AC	$17.60	$8.80	$13.20
10	314	Brush Management	Chemical - Spot Treatment - High - Picloram $110/gal. - 16 oz./ac + Triclopyr $111/gal. - 1 1/2 qt/ac or similar cost chemicals	AC	$58.85	$29.43	$44.14
11	314	Brush Management	Chemical - Spot Treatment - Low - Picloram $110/ga. - 38 oz./ac or similar cost chemical	AC	$36.54	$18.27	$27.41
12	314	Brush Management	Chemical - Spot Treatment - Medium - Picloram $110/gal. - 10 oz./ac + Triclopyr $111/gal. - 1 qt/ac or similar cost chemicals	AC	$39.85	$19.93	$29.89
13	314	Brush Management	Chemical - Tamarisk	AC	$153.85	$76.93	$115.39
14	314	Brush Management	Chemical - Ultra Low - 2,4-	AC	$7.60	$3.80	$5.70

			D 1 pt./ac or similar cost chemical				
15	314	Brush Management	Chemical - Very High - Picloram $110/ga. - 2 pt./ac or similar cost chemical	AC	$31.35	$15.68	$23.51
16	314	Brush Management	Chemical - Very Low - Tebuthiron $8/lb., 1lb/ac or similar cost chemical	AC	$11.85	$5.93	$8.89
17	314	Brush Management	Chemical Application - Backpack - Spot Treatment, Rugged Terrain, or Riparian Area	AC	$88.00	$44.00	$66.00
18	314	Brush Management	Chemical Application - Ground Rig/Boom Applicator or Fixed-Wing Aircraft	AC	$10.00	$5.00	$7.50
19	314	Brush Management	Chemical Application - Ground Rig/Boom Applicator or Fixed-Wing Aircraft (greater than 200 mile ferry or less than 250 acres sprayed)	AC	$12.00	$6.00	$9.00
20	314	Brush Management	Chemical Application - Helicopter	AC	$12.00	$6.00	$9.00

21	314	Brush Management	Chemical Application - Helicopter (greater than 200 mile ferry or less than 250 acres sprayed)	AC	$15.00	$7.50	$11.25
22	314	Brush Management	Mechanical - Bulldozer	AC	$195.00	$97.50	$146.25
23	314	Brush Management	Mechanical - Standard Two-way Disk Aerate Harrow	AC	$60.00	$30.00	$45.00
24	314	Brush Management	Lop and Scatter heavy	AC	$75.00	$37.50	$56.25
25	314	Brush Management	Lop and Scatter light	AC	$20.00	$10.00	$15.00
26	314	Brush Management	Prescribed Burn	AC	As Bid		
27	378	Pond	Embankment, Compaction, or Abnormal Conditions (abnormal conditions = remote site, or adverse soil conditions such as saturated conditions or a rock shelf onsite)	CY	$5.00	$2.50	$3.75
28	378	Pond	Excavation	CY	$4.00	$2.00	$3.00
29	378	Pond	Small Pond (< .5 acre feet)	EA	$1,800.00	$900.00	$1,350.00
30	378	Pond	Medium Pond	EA	$2,800.00	$1,400.00	$2,100.00
31	378	Pond	Large Pond	EA	$3,800.00	$1,900.00	$2,850.00
32	1000	Mobilization	Equipment Mobilization Fee	MI	$4.00	$2.00	$3.00
33	382	Fence	Barbed Wire - Steel Posts 4 or 5 wire	FT	$2.15	$1.08	$1.61
34	382	Fence	Barbed Wire - Steel Posts 4 or	FT	$2.45	$1.23	$1.84

			5 wire, difficult terrain				
35	382	Fence	Let Down Fence - Mtn Areas 4 wire	FT	$3.20	$1.60	$2.40
36	382	Fence Removal	Removal of old fence	FT	$0.60	$0.30	$0.45
37	382	Fence	Barbed Wire - Wood Posts 4 or 5 wire	FT	$3.08	$1.54	$2.31
38	382	Fence	Cattle Guard	FT	$300.00	$150.00	$225.00
39	382	Fence	Electric - Does not include energizer or battery	FT	$1.00	$0.50	$0.75
40	382	Fence	Electric Fence Charger (either solar energizer and battery, or transformer)	EA	$450.00	$225.00	$337.50
41	382	Fence	Pole - Use limited to areas where standard fence types can not be used for reasons related to site conditions and/or climatic conditions. No more than 1/8 mile per contract	FT	$13.00	$6.50	$9.75
42	382	Fence	Wildlife Fence Markers	FT	$0.06	$0.03	$0.05
43	382	Fence	Woven Wire w/Barbed Wire Strands	FT	$2.00	$1.00	$1.50
44	382	Fence	Fence-All Types	FT	As Bid		
45	383	Fuel Break	Range Fuel Break	AC	$160.00	$80.00	$120.00
46			≤ 2" Pipeline-Above Ground not buried	FT	$1.25	$0.63	$0.94

			including installation				
47	516	Pipeline	≤ 2" Pipeline- All Types- Includes material, installation, and labor costs	FT	$2.10	$1.05	$1.58
48	516	Pipeline	3" - All Types	FT	$3.50	$1.75	$2.63
49	516	Pipeline	Horizontal Road Boring - Additional Feet of Drilling (Beyond 100')	FT	$30.00	$15.00	$22.50
50	516	Pipeline	Road Crossing Carrier	FT	$4.00	$2.00	$3.00
51	521A	Pond Sealing or Lining, Flexible Membrane	Earth Pond Membrane Synthetic Lining - Covered	SQ FT	$1.80	$0.90	$1.35
52	521A	Pond Sealing or Lining, Flexible Membrane	Earth Pond Membrane Synthetic Lining - Exposed	SQ FT	$1.57	$0.79	$1.18
53	521B	Pond Sealing or Lining, Soil Dispersant	Soil Dispersant	SQ FT	$0.11	$0.06	$0.08
54	521C	Pond Sealing or Lining, Bentonite Sealant	Compacted Bentonite Sealant	SQ FT	$0.70	$0.35	$0.53
55	521D	Pond Sealing or Lining, Compacted Clay Treatment	Earth Pond Clay Lining (imported from within region & compacted - > 1 mile and ≤ 10 miles transport)	CY	$17.00	$8.50	$12.75
56	521D	Pond Sealing or Lining, Compacted Clay Treatment	Earth Pond Clay Lining (on-site clay - compacted - ≤	CY	$14.25	$7.13	$10.69

			1 mile transport)				
57	528	Prescribed Grazing	Use of a herder for animal management	Month	$1,200.00	$600.00	$900.00
58	528	Prescibed Grazing	Monitoring for Better management (Cannot exceed 7.5% of GIP Contracted dollars or $2500 whichever is less)	aum	$1.00	$0.50	$0.75
59	533	Pumping Plant	Frost Free Nose Pump - All Costs	EA	$4,700.00	$2,350.00	$3,525.00
60	533	Pumping Plant	Phase Converter - Fixed Cost	EA	$716.00	$358.00	$537.00
61	533	Pumping Plant	Phase Converter - Variable Cost	HP	$100.00	$50.00	$75.00
62	533	Pumping Plant	Pump - Centrifugal - w/Motor, Hoses, Wiring, Control Panel, Concrete Pad, Shelter, and Installation - .5 to 1.5 HP - Fixed Cost	EA	$1,500.00	$750.00	$1,125.00
63	533	Pumping Plant	Pump - Centrifugal - w/Motor, Hoses, Wiring, Control Panel, Concrete Pad, Shelter, and Installation - .5 to 1.5 HP - Variable Cost	HP	$800.00	$400.00	$600.00
64	533	Pumping Plant	Pump - Jet - w/Motor,	EA	$1,270.00	$635.00	$952.50

			Hoses, Wiring, Control Panel, Concrete Pad, Shelter, and Installation - .5 to 1 HP - Fixed Cost				
65	533	Pumping Plant	Pump - Jet - w/Motor, Hoses, Wiring, Control Panel, Concrete Pad, Shelter, and Installation - .5 to 1 HP - Variable Cost	HP	$1,000.00	$500.00	$750.00
66	533	Pumping Plant	Pump w/1 Phase Motor, Hoses, Wiring, Control Panel, Concrete Pad, Shelter, and Installation - 1 to 10 HP - Fixed Cost	EA	$2,500.00	$1,250.00	$1,875.00
67	533	Pumping Plant	Pump w/1 Phase Motor, Hoses, Wiring, Control Panel, Concrete Pad, Shelter, and Installation - 1 to 10 HP - Variable Cost	HP	$500.00	$250.00	$375.00
68	533	Pumping Plant	Solar/Windmill	EA	$18,000.00	$9,000.00	$13,500.00
69	533	Pumping Plant	Surface Solar System	EA	$3,000.00	$1,500.00	$2,250.00
70	533	Pumping Plant	Solar 50 - 150 ft. lift	EA	$5,000.00	$2,500.00	$3,750.00
71	533	Pumping Plant	Solar - 150 ft. lift	EA	$8,000.00	$4,000.00	$6,000.00
72	533	Pumping Plant	Solar - 150-300 ft. lift	EA	$15,000.00	$7,500.00	$11,250.00
73	533	Pumping Plant	Solar - 300+ ft. lift	EA	$20,000.00	$10,000.00	$15,000.00

74	550	Range Planting	Fixed wing or ground broadcast	AC	$10.00	$5.00	$7.50
75	550	Range Planting	Helicopter	AC	$12.00	$6.00	$9.00
76	550	Range Planting	Fixed wing or Ground broadcast greater than 200 mile ferry or less than 250 acres planted	AC	$12.00	$6.00	$8.00
77	550	Range Planting	Helicopter greater than 200 mile ferry or less than 250 acres planted	AC	$15.00	$7.50	$11.25
78	550	Range Planting	Back Chaining	AC	$25.00	$12.50	$18.75
79	550	Range Planting	Range Drill - Single Drill No Seedbed Preparation	AC	$20.00	$10.00	$15.00
80	550	Range Planting	Range Drill- Multiple Drills No Seedbed Preparation	AC	$15.00	$7.50	$11.25
81	550	Range Planting	Seed	AC	$45.00	$22.50	$33.75
82	550	Range Planting	Seed	AC	As bid not to exceed $100.00		
83	574	Spring Development	Basic Springbox or Pipe System	EA	$3,500.00	$1,750.00	$2,625.00
84	574	Spring Development	Medium Springbox or Pipe System	EA	$7,500.00	$3,750.00	$5,625.00
85	574	Spring Development	Complex Springbox or Pipe System	EA	$15,000.00	$7,500.00	$11,250.00
86	574	Spring Development	Box Collector System	EA	$3,500.00	$1,750.00	$2,625.00

87	574	Spring Development	Complex Pipe Collector System	EA	$10,000.00	$5,000.00	$7,500.00
88	575	Animal Trails and Walkways	Animal Trails and Walkways - 6' wide	FT	$0.20	$0.10	$0.15
89	614	Watering Facility	Escape Ramp	EA	$50.00	$25.00	$37.50
90	614	Watering Facility	Rubber tire 1300 gallons or more	GAL	$1.25	$0.63	$0.94
91	614	Watering Facility	Rubber tire less than 1300 gallons	GAL	$1.75	$0.88	$1.31
92	614	Watering Facility	Standard Watering Facility w/Gravel or Concrete Base,	GAL	$1.50	$0.75	$1.13
93	614	Watering Facility	Storage Tank or Bottomless Steel-Rim Tank greater than 20-foot diameter	GAL	$1.20	$0.60	$0.90
94	614	Watering Facility	Trough - Automatic, Insulated,	EA	$1,600.00	$800.00	$1,200.00
95	636	Water Harvesting Catchment	Catchment Structure (such as wood post and corrugated metal structure)	SQ FT	$5.51	$2.76	$4.13
96	636	Water Harvesting Catchment	Flexible Membrane or Geosynthetic Liner	SQ FT	$1.60	$0.80	$1.20
97	642	Water Well	All Types and Sizes - Includes all costs - Pump is to be contracted under Pumping Plant (533)	FT	$65.00	$32.50	$48.75

LSSC Monitoring Plan, Appendix I Attachment 2: Template for tracking annual public/private investment in livestock grazing infrastructure.

Year ______________

Infrastructure Category & Project Name	Cost/Year (1000's of dollars)									
	Producer	**GIP**	**NRCS**	**USFS**	**BLM**	**USFWS**	**WRI**	**MAWP** [1]	**Other** (specify)	**Category Subtotal**
	Cattle Management (fence, corral, cattle guard, etc.)									
	Water management (well, pipe, solar pump, etc.)									
	Veg treatment (removal, regrowth, thinning, etc.)									
Total										
Adjustment for inflation from 2017 (±%)										
Total inflation adjusted producer costs (by funder and grand total)										

[1] Moab Area Watershed Partnership

LSSC Monitoring Plan, Appendix I Attachment 3. Guidelines for Selection of Key Sites

Sites that have previously been established, meet the criteria below, and are sufficient to represent the pastures in which they reside will get top priority for being monitored. The principles that resound through the literature for key site selection include locating sites that:

- Are expected to respond both positively and negatively to positive and negative management actions, respectively. (Probably the most important factor for selecting key sites)
  - Establishing monitoring sites only within areas that are ecologically resilient to management changes will be counterproductive.
  - Sites should not be selected at random. Not selecting at random allows the selection team to ensure that management actions are considered in site selection.
- Are representative of the area, and conditions of the area, being monitored within the dominant vegetation type (representative of the ecological site).
  - Each site should only include a single vegetation type or ecological site.
  - If comparison reference sites are used to measure change and isolate the effects of management, comparison sites should be in the same ecological site and climate conditions as the key sites selected.
- Are selected collaboratively by organizations that have different perspectives and stakes in the project.
  - Biotic, abiotic, and economic factors should be included in selecting sites.
- Are selected based on historic knowledge of the larger areas being monitored and whether those areas fit into the management objectives/plans of the projects.
- Are ground-truthed, even if originally selected from aerial photographs, other maps, or personal experience.
- Are in areas of interest in management plans or objectives, but may not be representative of larger vegetation types.
  - These sites are not technically key sites, but are critical areas, that should be monitored nonetheless.
  - These sites are generally not the majority of the monitoring sites, unless the main management objectives of the project include managing the areas of interest below.
  - Areas of interest may include:
    - Riparian areas
    - Sensitive species habitat or key species
    - Invasive species populations/infestations

LSSC Monitoring Plan, Appendix I Attachment 4: Sampling Locations by Community Type and Geographic Reference

Proposed Allotment	Proposed Pasture	Name/Associated Agency Site	LSSC Site	Easting (UTM NAD83)	Northing (UTM NAD83)	Vegetation Community Type	Exclosure
Hatch Point	Anticline	KA 25	12	621383	4255272	Grass	0
	Chets Ledge	KA 12	10	626747	4246648	Grass	0
	Eight Mile	KA 1	8	622718	4234293	Sagebrush	0
	Flat Iron North	KA 6	6	631215	4246816	Grass	0
	Hatch Point	Trough Flat	1	620358	4250246	Grass	2-way
		KA 4	11	623498	4247408	Sagebrush	0
	Soup Rock	KA 16	7	629116	4232937	Sagebrush	2-way
	Three Mile	KA 15	9	630021	4239011	Grass	0
Black Ridge	Black Ridge	New Site	14	641004	4249958	Grass	0
	Browns Hole	KA 24	5	639010	4244158	Sagebrush	0
	Cottonwood East	KA 5A	3	644124	4248354	Grass	0
	Cottonwood West	Steve's Point	13	641613	4248357	Grass	0
	Lower Kane	KA 2	4	622647	4257512	Grass	2-way
	Mail Box	KA 3	2	635185	4249583	Grass	2-way
Dorry	Slaughter Flat	SS-6 Slaughter Flat #1	18	644298	4251252	Sagebrush	0
	Upper Dorry	Southern Upper Dorry	21	648312	4257371	Mountain Brush	3-way
La Sal	Big Pasture	Big Pasture	17	659671	4252741	Grass	0
	Buck Hollow	Lackey Spring	15	651745	4247865	Grass	0
	Chicken Creek	New Site	19	658895	4251195	Grass	0
	La Sal Pass	Big Flat Aspen	16	655753	4251649	Aspen	3-way
		Upper La Sal Pass	20	652588	4253884	Grass	0
		Upper La Sal Creek Meadow	22	657424	4250761	Grass	0

Hatch Point	La Sal Junction	West Coyote Creek	27	640670	4240771	Riparian	0
	Three Mile	Three Mile Creek	26	632697	4236788	Riparian	0
	Trout Water	Trout Water	28	625179	4243339	Riparian	0
Black Ridge	Cottonwood East	Cottonwood Creek	29	643756	4246474	Riparian	0
	Upper Kane	Muleshoe Creek	30	634357	4248787	Riparian	0
La Sal	Chicken Creek	Beaver Creek	25	659948	4250388	Riparian	3-way
	La Sal Creek	Deer Creek	24	655676	4247848	Riparian	0
	La Sal Pass	La Sal Creek	25	655102	4251636	Riparian	0

Proposed Allotment	Proposed Pasture	Size Cattle X	Size All X	Cost Cattle	Cost All X	Total Cost	Comments
Hatch Point	Far North Hatch Point (Anticline)						
	Chets Ledge						
	Eight Mile						
	Flat Iron North						
	Hatch Point	1 acre (835 ft)	1 acre	$1,346	$2,647	$3,993	
	Soup Rock	2 ac (1670 ft)	0?	$3,591		$3,591	Why no 4-way?
	Three Mile						
Black Ridge	Black Ridge						
	Browns Hole						
	Cottonwood East						
	Cottonwood West						
	Lower Kane	1 acre	1 acre	$1,346	$2,647	$3,993	Location and blackbrush issue
	Mail Box	1 acre	1 acre	$1,346	$2,647	$3,993	Is this a large enough site?
Dorry	Slaughter Flat						
	Upper Dorry	1 acre	1 acre	$1,346	$2647	$3,993	Access issues/Better site?
La Sal	Big Pasture						
	Buck Hollow						

	Chicken Creek						
	La Sal Pass	1 acre	1 acre	$1,346	$2,647	$3,993	
		1 acre	1 acre	$1,346	$2,647	$3,993	Too big? Lay down fencing?
Hatch Point	Hatch Point						
	La Sal Junction						
	Three Mile						
	Trout Water						
La Sal	Chicken Creek	1 acre	1 acre	$1,346	$2,647	$3,993	Location and Size?
	La Sal Creek						
	La Sal Pass						
		835			**Total**	**$31,542**	

Labor for cattle fencing was \$1.15/linear foot (Sego Boundary) but only \$1.00/foot for lay down fencing on the Wasatch Plateau (FS) so \$1.06/ft was used in the above calculation								
Materials (FS) cost of cattle fencing is \$0.90 - \$0.94								
Total cost of labor and materials for cattle fencing was calculated at \$2.15 /foot (GIP)								
10' T-post cost \$9.99 each at Home Depot								17.3333
Materials at 12' spacing \$1.17/ft								
Labor Cost of \$2.00/ft was estimated								
Total cost \$3.17/ft								

Standard 4 Strand barb wire fence 16 foot spacing							Total Cost	Per linear foot
Fence length in miles	T-Posts	Rolls of Barb Wire	Wire Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	330	16	330	52	256	2.5	**$3,590.56**	0.68
2	660	32	660	60	512	5	**$6,851.12**	
3	990	48	990	90	768	7.5	**$10,276.68**	
4	1320	64	1320	120	1024	10	**$13,702.24**	
5	1650	80	1650	150	1280	12.5	**$17,127.80**	
Prices	$5.50	$75.00	$0.44	$7.50	$0.060	$10.000		
Standard 4 Strand barb wire fence 12 foot spacing								
Fence length in miles	T-Posts	Rolls of Barb Wire	Wire Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	440	16	440	30	256	2.5	**$3,664.17**	0.69
2	880	32	880	60	512	5	**$7,328.34**	
3	1320	48	1320	90	768	7.5	**$10,992.50**	
4	1760	64	1760	120	1024	10	**$14,656.67**	
5	2200	80	2200	150	1280	12.5	**$18,320.84**	
	$4.80	$70.00	$0.44	$7.50	$0.053	$10.000		
Standard 5 Strand barb wire fence 16 foot spacing								
Fence length in miles	T-Posts	Rolls of Barb Wire	Wire Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	330	20	330	30	256	2.5	**$3,367.77**	0.64
2	660	40	660	60	512	5	**$6,735.54**	
3	990	60	990	90	768	7.5	**$10,103.30**	
4	1320	80	1320	120	1024	10	**$13,471.07**	
5	1650	100	1650	150	1280	12.5	**$16,838.84**	
	$4.80	$70.00	$0.44	$7.50	$0.053	$10.000		

Standard 5 Strand barb wire fence 12 foot spacing								
Fence length in miles	T-Posts	Rolls of Barb Wire	Wire Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	440	20	440	30	256	2.5	**$4,133.96**	0.78
2	880	40	880	60	512	5	**$8,267.92**	
3	1320	60	1320	90	768	7.5	**$12,401.88**	
4	1760	80	1760	120	1024	10	**$16,535.84**	
5	2200	100	2200	150	1280	12.5	**$20,669.80**	
	$5.00	$75.00	$0.44	$7.50	$0.060	$10.000		
Let Down 4 Strand barb wire fence 16 foot spacing								
Fence length in miles	T-Posts	Rolls of Barb Wire	Wood Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	330	16	660	52	1246	15	**$3,989.76**	0.76
2	660	32	1320	60	2236	30	**$7,634.16**	
3	990	48	1980	90	3226	45	**$10,960.56**	
4	1320	64	2640	120	4216	60	**$15,252.96**	
5	1650	80	3300	150	5206	75	**$19,062.36**	
	$5.00	$75.00	$0.75	$7.50	$0.060	$12.000		
Let Down 4 Strand barb wire fence 12 foot spacing								
Fence length in miles	T-Posts	Rolls of Barb Wire	Wood Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	440	16	440	52	1576	20	**$5,224.56**	0.99
2	880	32	880	60	2896	40	**$10,103.76**	
3	1320	48	1320	90	4216	60	**$15,147.96**	
4	1760	64	1760	120	5536	80	**$20,192.16**	
5	2200	80	2200	150	6856	100	**$25,236.36**	
	$5.50	$75.00	$2.00	$7.50	$0.060	$12.000		

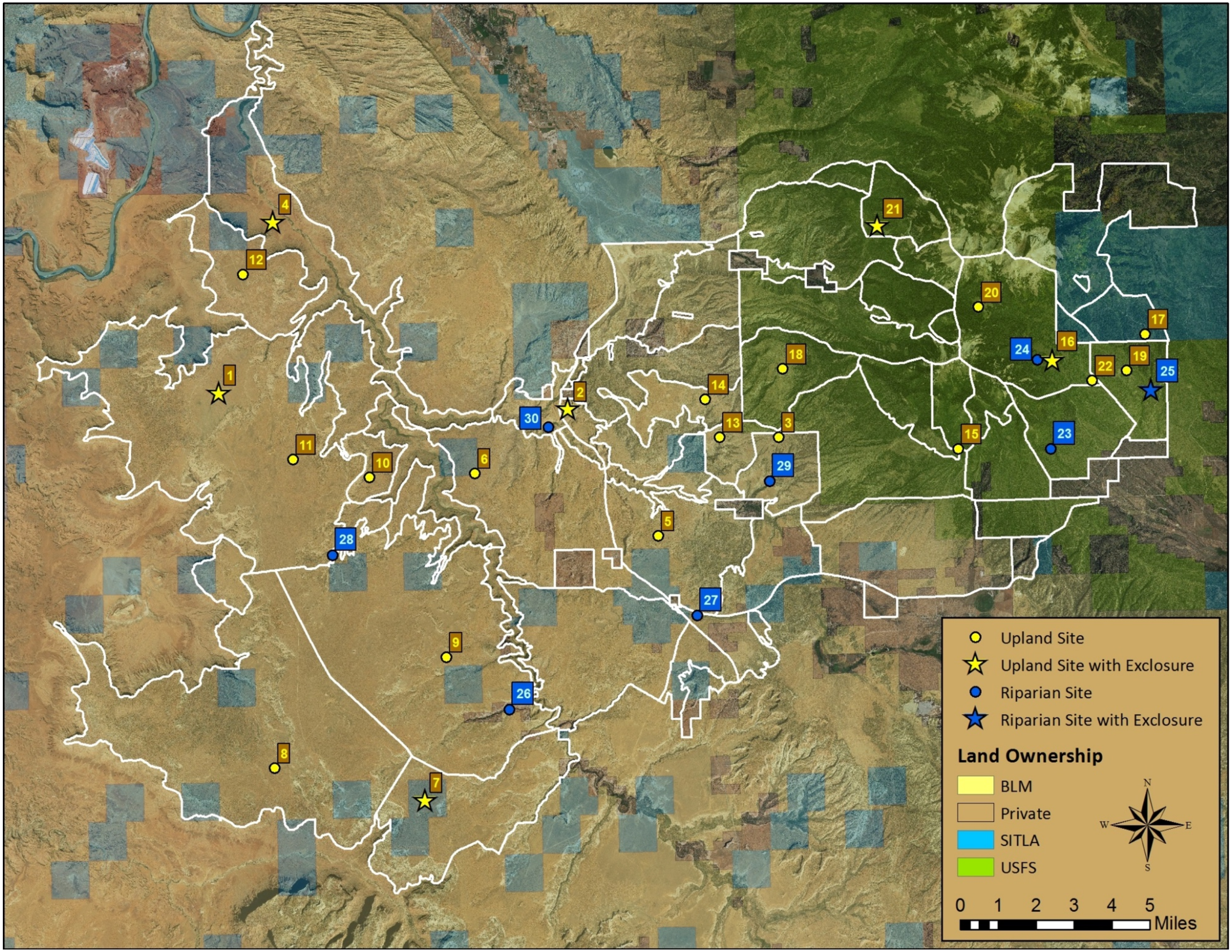
Cost of contractor per foot

Gentry boundary $3.50

Standard 3 Strand barb wire fence 16 foot spacing							Total Cost	
Fence length in miles	T-Posts	Rolls of Barb Wire	Wire Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	330	12	330	52	256	2.5	**$3,290.56**	0.62
2	660	24	660	104	512	5	**$6,581.12**	
3	990	36	990	156	768	7.5	**$9,871.68**	
4	1320	48	1320	208	1024	10	**$13,162.24**	
5	1650	60	1650	260	1280	12.5	**$16,452.80**	
	$5.50	$75.00	$0.44	$7.50	$0.060	$10.000		

Standard 7 Strand barb wire 8' exclosure fence @ 12 foot spacing								
Fence length in miles	T-Posts	Rolls of Barb Wire	Wire Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	440	16	880	30	1024	2.5	**$6,182.07**	1.17
2	880	32	1760	60	2048	5	**$12,364.14**	
3	1320	48	2640	90	3072	7.5	**$18,546.22**	
4	1760	64	3520	120	4096	10	**$24,728.29**	
5	2200	80	4400	150	5120	12.5	**$30,910.36**	
	$9.99	$70.00	$0.44	$7.50	$0.053	$10.000		

Standard 7 Strand barb wire 8' exclosure fence @ 16 foot spacing							Total Cost	
Fence length in miles	T-Posts	Rolls of Barb Wire	Wire Stays	Cedar Brace posts	Feet of Smooth wire	Anealed Wire LBS		
1	330	16	660	52	1024	2.5	**$5,263.54**	1.00
2	660	32	1320	60	2048	5	**$10,197.08**	
3	990	48	1980	90	3072	7.5	**$15,295.62**	
4	1320	64	2640	120	4096	10	**$20,394.16**	
5	1650	80	3300	150	5120	12.5	**$25,492.70**	
Prices	$9.99	$75.00	$0.44	$7.50	$0.060	$10.000		


Upland Site
Upland Site with Exclosure
Riparian Site
Riparian Site with Exclosure
Land Ownership
BLM
Private
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LSSC Monitoring Plan, Appendix I Attachments 5.1-6.

Attachment 5.1: UDWQ Protocols for Continuous Temperature Monitoring -- Standard Operating Procedure for Temperature Data Loggers

SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for the installation and maintenance of temperature loggers in Utah's natural (rivers, streams, lakes) or engineered (ditches, canals, reservoirs) surface water bodies. This SOP applies to any DWQ monitor or non-DWQ cooperator installing or maintaining temperature loggers.

Traditionally, water quality assessments were based on "grab" samples that capture conditions at a single point in time. Such collection efforts complicate the interpretation of parameters like temperature and DO, which exhibit wide daily fluctuations. However, technology is improving and DWQ increasingly has data from deployed instruments that quantifies water quality parameters at a high frequency (e.g., every 15 minutes) for several days or weeks.
DWQ is working on developing assessment methods that help us better interpret water quality data fro m these more accurate data sources. Targeted monitoring, TMDL. Photosynthetically Active Radiation (**PAR**) **sensors**

http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=261911

SUMMARY OF METHOD

The temperature data loggers will be programmed to log and record time and temperature of a water body every 15 minutes. The logger will then be attached to an object on the banks of the water body which will remain in place during expected high flows or flooding events. A stainless-steel cable with a loop on the free end will be the general method for attaching the logger to the object.

DEFINITIONS

Temperature Data Loggers:	This will refer to the Utah DWQ's preferred logger, the Onset Computer Corporation's HOBO® Pendant Temperature Data Logger, (Part # UA-001-64).
Base Station:	An optical interface that connects to a computer by USB to communicate with the logger and download data.

HEALTH AND SAFETY WARNINGS

In most cases, installation of temperature data loggers will take place on stream banks. Most sites for installation of temperature data loggers are near bridges fortified with rip-rap, which can be unstable, slippery, and sharp. Stream banks, where loggers are often installed are steep, slippery, and covered in cobble. Working near water in waders poses a drowning hazard, and working near water in the winter poses a hypothermia hazard.

CAUTIONS

The temperature data loggers are relatively robust, but care must be taken in the placement of the loggers. Plastic tags identifying the logger as property of the State of Utah and a brief description of the purpose and contact number should be used. Boulders or other large debris may crush the loggers. A stable object must be used to anchor the logger.

INTERFERENCES

Erroneous temperature measurements may be taken if the logger is deployed in an area of the water body with stagnant water, particularly in the sun. Care should be used to ensure the logger is in flowing water, if applicable, or in shade or deep enough water to prevent excessive heating by sunlight.

PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

Monitors that will be installing temperature data loggers are required to read this SOP annually and acknowledge they have done so via a signature page (see **Appendix 1**) that will be kept on-file at DWQ along with the official hard copy of this SOP. Before new personnel can program and install temperature data loggers, they must be trained by an experienced DWQ monitor. The signature page will be signed by both trainee and trainer to confirm that training was successfully completed and that the new monitor is competent in carrying out this SOP.

EQUIPMENT AND SUPPLIES

- ☐ Copy of this SOP
- ☐ Field Form (**Appendix 2**)
- ☐ HOBO® Pendant Temperature Data Logger (Part # UA-001-64)
- ☐ HOBOware 2.1 or later software to program the logger and download data
- ☐ Pendant Optic USB Base Station & Coupler (Part # BASE-U-1)
- ☐ Laptop or desktop computer to communicate with the logger
- ☐ Stainless Steel (SS), 3/32”, vinyl-coated braided cable, approximately 2 meter lengths
- ☐ 3/32” cable ferrules to attach SS cable to the logger and to form a loop at the end.
- ☐ T-posts or lengths of rebar and installation method (sledgehammer or post driver) where a suitable object at the water body is not present.

 Tags to attach to the loggers identifying them as property of the State of Utah and the purpose of the logger. UT DWQ uses plastic keychains printed with “PLEASE DO NOT DISTURB! This instrument is property of the State of Utah and is being used to monitor the state’s water quality. Please call the Div. of Water Quality with any questions, (801)536-4300”

PROCEDURE

Calibration

- The HOBO® Pendant Temperature Data Loggers are calibrated at the factory and no calibration or standardization is necessary before use.

Installation

- Using HOBOware 2.1 or later software, program the loggers to log temperature readings every 15 minutes, using the procedure outlined in the software. The HOBO Pendant logger can be programmed to log immediately, or a delayed start may be used. In either case, ensure in the software that the unit is programmed and is logging or will begin logging at the programmed time and date. Include in the programming the name of the site and date of deployment.
- Cut the 3/32” stainless steel (SS) cable into approximately 2-3 meter lengths. Using the cable ferrules, attach the SS cable to the HOBO Pendant logger, and form a loop of cable on the other end that is large enough for the logger attached to the cable to pass through.
- Attach the ‘Property of’ identifying tag to the cable as well.
- At the water body where detailed temperature data are required, reconnoiter for an appropriate object to attach the temperature logger. A stout clump of brush, tree, fencepost or boulder are often used. If no object presents itself, a t-post can be inserted and used as the attachment point.
- Wrap the cable with logger attached around the anchoring object and pass the logger through the loop in the other end. Pull the cable tight around the object, and place the logger in the water body to be monitored.
    - This method ensures the logger is secure, but can also be removed easily for redeployment elsewhere.
    - Be mindful of the conditions discussed above in the interferences section when siting the logger.
- Make detailed records of the location of the logger
    - Take photos showing the relative location of the logger to the access point, routine monitoring location, obvious reference point, etc.
    - Take a GPS reading of the attachment point of the logger

- Make detailed notes about the location and method of attachment to aid in retrieval.

Data Retrieval

- Typically the temperature data loggers are deployed in the fall and left onsite until removal in the fall, at the end of the water year in October. Data retrieval and logger retrieval are essentially the same.
- Locate the logger and remove.
- Plug the Base Station into the computer's USB port and start HOBOware software.
- Insert the Pendant logger into the base station. Follow the software instructions to download the temperature data.
- As soon as feasible, upload the temperature data to the Utah DWQ servers, Monitors Folder, Temperature Probes sub-folder, which is backed up regularly to ensure data integrity.

DATA AND RECORDS MANAGEMENT

- The downloaded temperature data must be stored on the Utah DWQ's server so that it will be automatically backed up.

- Notify the Utah DWQ personnel responsible for the area where the temperature data logger was deployed that the data are ready for their specific use.

QUALITY ASSURANCE AND QUALITY CONTROL

Follow all procedures described in this SOP to ensure valid, high quality temperature measurements.

REFERENCES

Onset Computer Corporation's website: http://www.onsetcomp.com/, has links to their product's manuals and specifications, including:

- HOBO® Temperature Data Logger Manual: http://www.onsetcomp.com/files/manual_pdfs/9531-G-MAN-UA-001.pdf

- HOBOware Software Manual: http://www.onsetcomp.com/files/12730-F-MAN-BHW-UG_EN.pdf

Attachment 5.2. UDWQ Protocols for Continuous Temperature and Pressure Monitoring with Transduces

SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for the installation and maintenance of pressure transducers in Utah's natural (rivers, streams, lakes) or engineered (ditches, canals, reservoirs) surface water bodies. This SOP applies to any DWQ monitor or non-DWQ cooperator installing or maintaining pressure transducers. This SOP also outlines the responsibilities of DWQ monitors to perform inspections of pressure transducers and associated equipment while collecting water samples or performing flow measurements at a site where a pressure transducer has been installed.

Level TROLL 300 pressure transducers are a low-cost and robust method of determining near-continuous flow in streams that are not gaged by another agency (such as the U.S. Geological Survey or a utility). The pressure transducer consists of an "absolute" or "uncompensated" pressure sensor which measures absolute pressure and is not vented to allow for compensation for atmospheric pressure. Therefore, atmospheric pressure is subtracted from the absolute measurement to determine the pressure from water. The pressure transducer will log the depth of water at set time intervals. Recorded values are stored in the sensor itself and are periodically retrieved by field personnel. By combining these logs of depths with a number of discharge measurements taken at the site, a rating curve can be developed, correlating the depth of water with the measured discharge. Once this correlation has been established, discharge may be inferred from water depth alone.

Flow data is used by DWQ scientists and engineers for a variety of purposes including but not limited to:

- understanding the effect of hydrologic condition on aquatic life uses
- determining pollutant loading and inputs into receiving waterbodies
- setting permit requirements for discharge of treated wastewater
- understanding groundwater/surface water interactions
- characterizing current water quality conditions and detecting long-term changes

The information discussed in this SOP is not a substitute for equipment user manuals or other technical documentation. Consult the appropriate manual for a complete guide to the proper use, calibration, maintenance, deployment, and troubleshooting of pressure transducer equipment/software. This SOP is to be used as a reference but the complete user manual should always accompany the field personnel.

SUMMARY OF METHOD

The transducers are programmed to log the depth of water every 15 minutes. The installation site will be scoped for feasible placement of the transducer inside of a PVC pipe with the bottom of the pipe as close as possible to the low-water level of the stream and the top of the pipe as high as feasible above the current water level and the expected high water level. The PVC pipe will act as a stilling well to even out the wave action of the flowing water, and to prevent damage to the transducer by natural causes or intentional damage. The pipe will be attached at the site using one of a number of methods to safeguard against high flows and vandalism.

DEFINITIONS

Discharge:	A term used in this SOP interchangeably with "flow". This is the volume of water flowing per unit of time. A flow or discharge measurement is a manual measurement of stream flow performed by a DWQ monitor/cooperator.
Gaging station:	This is a site where flow is being measured continuously and automatically using devices such as, but not limited to, pressure transducers.
Pressure transducer:	A device that measures pressure
PVC:	Polyvinyl chloride
Reference level:	The fixed elevation or height under the water at which the pressure transducer is installed
Stage:	The height of the surface of the water in relation to the reference level
Stilling well:	A cylinder installed near a body of water used to hold and protect hydrological sensors. The stilling well allows water to move in and out freely to interact with sensors but dampens wave and current action so as to provide a representative water level and to reduce noise in water level data.

HEALTH AND SAFETY WARNINGS

In most cases, installation of pressure transducers will take place on stream banks. Most sites for installation of pressure transducers are near bridges fortified with rip-rap, which can be unstable, slippery, and sharp. Stream banks, where transducers are often installed are steep, slippery, and covered in cobble. Power tools, including hammer drills and sawzalls, can be hazardous if used improperly. Working near water in waders poses a drowning hazard, and working near water in the winter poses a hypothermia hazard.

CAUTIONS

Since the pressure transducer relates recorded depth of the transducer to recorded flow at the site, it is imperative that the transducer remain at the reference level, or height under water, for the duration of measurements. The transducer will need to be removed from the PVC pipe to download data and to clean out any debris or sediment, and care should be exercised to return the transducer to the same level from which it was retrieved.

Flow measurements (see DWQ's SOP for Stream Flow Measurements) should be conducted by monitoring staff as accurately as possible as a limited number of flow measurements will be used to interpolate a range of discharge from the depths recorded by the transducer.

INTERFERENCES

The PVC pipe must be anchored firmly enough to prevent movement, which would change the reference depth of the transducer.

PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

A senior Utah DWQ monitoring staff member will be the primary responsible party for installation of pressure transducers and development/maintenance of rating curves. This monitor will also be responsible for training new field staff.

Personnel installing pressure transducers and taking flow measurements should be knowledgeable of the relation between stream depth, or stage, and stream flow. Programming the transducers requires knowledge of computers and deployment software. Installation of the stilling wells and transducers is physically demanding and requires the use of a T-post driver, 3 pound hammer, hammer drill, and cable cutters.

Monitors that may be performing inspections of installed pressure transducers are required to read this SOP annually and acknowledge they have done so via a signature page (see Error! Reference source not found.) that will be kept on-file at DWQ along with the official hard copy of this SOP. Before new personnel can install pressure transducers or perform gage maintenance they must be trained by an experienced DWQ monitor. The signature page will be signed by both trainee and trainer to confirm that training was successfully completed and that the new monitor is competent in carrying out this SOP.

EQUIPMENT AND SUPPLIES

- ☐ Copy of this SOP
- ☐ Field Form (**Appendix 1**)
- ☐ In-Situ Inc. Level TROLL 300 logging pressure transducer or equivalent.
- ☐ Win-Situ 5 logger software
- ☐ In-Situ Inc. RS232 TROLL Com Direct Connect communication cable

- Laptop or desktop computer to communicate with the Level TROLL 300
- 1.5-inch diameter PVC Schedule 40 electrical conduit pipe, 10-foot length cut to fit specific installation
  - ¼- inch holes drilled from end to 12 inches up pipe, every 90 degrees around and every 2 inches to allow water to equilibrate in pipe
  - 3/8-inch hole drilled two inches from top of pipe, to allow water to equilibrate in pipe and for the attachment of padlock
- Two 1.5-inch PVC caps
  - Bottom cap drilled with ¼-inch holes in bottom for water to equilibrate and sediment to drop out; attached to pipe with self-tapping screws to allow removal for cleaning
  - Top cap friction fitted onto top of pipe, no modifications
- Lengths of 3/32-inch vinyl coated braided stainless-steel (SS) cable to attach pressure transducer inside PVC pipe to padlock; cut to fit specific installation
- 3/32-inch cable ferrules to attach SS cable to pressure transducer and form loop in top of cable to attach to padlock
- Attachment materials and tools
  - ¾-inch SS strapping, seals, and tensioner
  - Hammer drill, 3/32-inch masonry bits, ¼-inch X 2-inch masonry screws
  - Powder-actuated nailer, powder charges, and concrete pins
  - 1.5-inch two-hole metal conduit straps
  - 5-foot T-posts, post driver, 3 pound single jack sledgehammer, 2-foot rebar
- Keyed or combination long-shackle padlock to secure the transducer on the SS cable in the PVC pipe (Utah DWQ uses combination locks; combination code can be found in the site portfolio)
- In-Situ Inc. BaroTROLL, one unit per general geographic area to provide a log of the atmospheric pressure

PROCEDURE

Calibration

1) The In-Situ Level TROLL 300s are calibrated at the factory and no calibration or standardization is necessary before use.

2) The life of a transducer and how long it will maintain its calibration is dependent upon the duration of use, exposure to extreme environmental conditions, and how carefully it is handled during storage, transportation, and use. If needed, calibration is possible with the Level TROLL and the procedure is detailed in the Level TROLL Operators Manual.

3) Record the serial number and factory calibration date for the pressure transducer on the field form (**Appendix 1**) maintained in the site portfolio folder.

Installation

1) Determine where detailed flow measurements are required and assess the best location to install the stilling well and transducer. The stilling well should be mounted to a permanent object (*e.g.*, bridge piling) at a location where the channel cross section is not likely to change over time. In addition, this location should be suitable for obtaining discharge measurements by wading or deploying a Q-boat from a bridge or cable.

2) Using Win-Situ 5 or equivalent software, program the transducers to log depth readings every 15 minutes, using the procedure outlined in the software. The Level TROLLs can be programmed to log immediately, or a delayed start may be used. In either case, ensure in the software that the unit is programmed and is logging or will begin logging at the programmed time and date. Include in the programming the name of the site and date of deployment.

3) Based upon the site, determine the length of the PVC pipe that is feasible to reach down to low water and ideally above high water. The transducers are water-tight, so no damage will occur if the top of the pipe is not above water throughout the year.

4) Using this determined length, cut the PVC pipe from the top, if necessary, to the appropriate length. The 3/8-inch hole for the padlock will need to be re-drilled 2 inches below the top of this new length of pipe.

5) Using the 3/32-inch SS cable and ferrules, make a tether for the pressure transducer inside the PVC pipe.

    a) Place a ferrule on the cable, run the end through the eyelet on the top of the transducer then through the ferrule again, forming approximately a 2-inch loop. Clamp in place using a ferrule clamp or the 3-pound sledge and a hard surface.

    b) Holding the other end of the cable, lower the transducer on the cable into the pipe until it reaches the bottom cap. Pull the transducer up approximately ½-inch above the cap and mark the cable at the location of the top hole in the pipe for the padlock. Form a loop with this mark at the top, and cut the cable with adequate length to make this loop. Check that the transducer will be approximately ½" above the bottom cap when the padlock is run through the pipe and top loop of the tether, and clamp the top loop using one of the above methods.

    c) This will create a tether of set length with the transducer at the bottom end and an approximately 2-inch loop at the top end.

6) The transducer on the end of the tether can be inserted into the stilling well, and secured by inserting the free end of the padlock shackle through one of the 3/8-inch holes at the top of the well, hooking the tether loop over the shackle inside the pipe, then inserting the shackle through the other hole (other side of pipe) and locking the padlock.

7) Place the top cap on the stilling well.

8) To attach the stilling well at the determined site, one of several methods can be employed, listed in order of preference:

   a) If using a bridge pylon or other vertical structure that extends into the stream as low as the low water mark, the stilling well can be strapped to the downstream side (to minimize wakes caused by the structure) using the SS strapping, seals and SS tensioner. Detailed instructions on using these tools can be found at: http://www.uline.com/PDF/IH-1273.PDF.

   b) If using a vertical surface, such as a bridge abutment at the downstream side where the SS strapping cannot be wrapped around the surface, the 1.5-inch metal conduit straps can be used to attach the stilling well. If the vertical surface is concrete, as is likely, a hammer drill and concrete screws or powder-actuated nailer and concrete nails will be used to attach the stilling well, nailing or screwing down the straps over the stilling well in at least two spots, typically just above current water level and near the top of the well.

   c) If no vertical surface is present, the transducer can be attached to a diagonal surface, such as a stream bank. The transducer records absolute depth of water, so the stilling well in a diagonal position will not affect readings. Determine best location of stilling well, and mark two or more locations to drive T-posts or sections of rebar into the stream bank to use as attachment points for the stilling well. Position the posts downstream of the stilling well location and drive them as deep as possible to provide a good anchor and prevent a hazard. Attach the stilling well using the SS strapping around the well and post to prevent movement and vandalism.

9) Record the date of deployment on the field form (**Appendix 1**).

Inspection and Maintenance

1) The transducers should be inspected whenever feasible to ensure no damage, shifting, or vandalism has occurred. All DWQ monitors are provided with a list of the sites that are gaging stations. Monitors perform a visual inspection of the gage each time they visit that site. In addition, the monitor responsible for maintaining DWQ's gaging stations may visit the site to perform inspections and maintenance at more frequent intervals.

2) The monitor responsible for maintaining DWQ's gaging stations will determine the frequency at which more detailed inspections of the pressure transducer and inside of the stilling well will be performed. The transducer can be removed from the well to remove debris or sediment and the pressure transducer and stilling well can be cleaned. At a minimum, a detailed inspection and maintenance should be performed during data retrieval.

3) Record that an inspection and/or maintenance was performed on the field form (**Appendix 1**).

Data Retrieval

1) To retrieve the pressure transducer, remove the PVC cap and unlock the padlock. Pull on the SS cable to lift the pressure transducer out of the pipe.

2) To download the data, remove the protective cap from the transducer and plug it into the laptop using the RS232 Direct Connect cable. Win-Situ 5 will recognize the instrument, and prompt the user to connect and download the data.

3) Make certain the transducer is once again logging at the 15 minute intervals, and reinsert into the stilling well, attaching the tether with the padlock. The 2-inch loop ensures that the pressure transducer is lowered to the same depth from which it was retrieved.

4) Record that data retrieval was performed on the field form (**Appendix 1**).

DATA AND RECORDS MANAGEMENT

- The field form in **Appendix 1** should be included in the site portfolio of every site where a pressure transducer has been installed. Use this form to record installation of the pressure transducer, inspections and maintenance performed, data retrievals performed, and to note when a flow measurement has been performed manually by a monitor. In addition, monitors/cooperators should notify the senior monitor responsible for the gaging station when a flow measurement has been performed at that site.

- Upon returning to the office with downloaded transducer data, the file should be uploaded to the Monitors folder on the Utah DWQ server to safeguard it against loss.

- The Win-Situ 5 software will store the logged depths and the logged barometric pressures. In-Situ Inc.'s Baro Merge Software will compensate the logged depths for changes in barometric pressure, improving accuracy.

- The BaroTROLL is identical to the Level TROLL except it is deployed in air. The BaroTROLLs are set up the same way, recording barometric pressure every 15 minutes. They need to be downloaded the same way as well, at the same time as the Level TROLLs.

- Using flow determinations and the logged depth at the time of flow measurement, a stage-discharge rating curve will be created. From the curve, an equation can be made that will allow all of the logged depths to be converted into flow estimations. Flow measurements are performed each time monitors collect water samples, if conditions allow. The monitor responsible for maintaining DWQ's gaging stations will determine the frequency at which flow measurements performed specifically for rating curve assessments/adjustments need to be performed. A minimum of five flow determinations should be made for a reasonable stage-discharge rating curve.

QUALITY ASSURANCE AND QUALITY CONTROL

Follow all procedures described in this SOP to ensure valid, high quality pressure transducer measurements. Follow all procedures described in DWQ's SOP for Stream Flow Measurement to ensure valid, high quality flow measurements that can be used to develop rating curves for gaged sites.

Keep up-to-date equipment maintenance records and calibration data (**Appendix 1**) with other site records to provide defense of quality data from installed pressure transducers.

REFERENCES

The In-Situ Inc. website (http://www.in-situ.com/) has Win-Situ software updates and helpful Quick Guides, Instrument Manuals, Instruction Sheets and Technical Notes including:

- Level TROLL 300, 500, 700, and BaroTROLL Operator's Manual (http://www.in-situ.com/Manuals)
- Win-Situ 5.0 User's Guide (http://www.in-situ.com/Win_Situ5)
- Level TROLL 300, 500, and 700 Quick Start Guide (http://www.in-situ.com/QuickStarts)
- Technical Note: Using Baro Merge Software (http://www.in-situ.com/Baro_MergeSoftware)

Goering, T. (2008). Pressure transducer installation, removal, and maintenance. Los Alamos National Laboratory Standard Operating Procedure SOP-5227, Revision 0, Effective Date 10/28/2009. http://www.lanl.gov/environment/all/ docs/qa/ep_qa/SOP-5227.pdf.

Yerington Mine Site. (2009). Pressure transducer water level monitoring standard operating procedure SOP-21, Revision 1, Revision Data 4/28/2009. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/cf0bac722e32d408882574260073faed/120f26eb0d420d8b882575e1006899ae/$FILE/SOP-21r1%20Pressure%20Transducer%20Water%20Level%20Monitoring.pdf.

Appendix 1 – Pressure transducer field form

(U:\WQ\PERMITS\MONITORS\Pressure Transducers\Pressure Transducer Field Form.pdf)

Utah DWQ, May 2011

Utah DWQ Pressure Transducers
Installation, Inspection and Maintenance Form

Site Name:_______________________________ STORET:_______________________________
Latitude:_______________________________ Longitude:_______________________________
Site Description:_______________________________
Pressure Transducer Make/Model/Serial Number:_______________________________
Pressure Transducer Factory Calibration Date:_______________ Installation/Deployment Date:_______________
Installation Personnel:_______________________________
Notes from Installation:_______________________________

Date	Monitor Initials	Visual Inspection Performed (Y or N)	Visual Inspection Okay (Y or N)	Data Retrieval Performed (Y or N)	Battery Life Remaining	Memory Remaining	Maintenance Performed (Y or N)	Flow Measurement Performed (Y or N)	Equipment Condition, Comments, Describe Maintenance

U:\WQ\PERMITS\MONITORS\Pressure Transducers\Pressure Transducer Field Form.doc Page _____ of _____

Attachment 5.3. UDWQ Protocols for Nutrient and Water Chemistry Samples

Gear for Water Chemistry Crews

- Geopump
- Sonde to obtain: instantaneous DO, temperature, specific conductance and pH.
- Foot tape (for discharge)
- Flow Meter
- GPS/Maps to locate previous sites or establish new sites
-
- Water chemistry bottles (unfiltered nutrients, filtered nutrients)
- Water chemistry filters (course and fine)
-
- Cooler with wet ice
- Water chemistry data sheets
- Sharpies and pencils

Procedures: Water Quality Crews

For New Sites

1. ***Locate the established site**** and conduct quick recon; feel free to ***move up or downstream*** to accommodate unforeseen monitoring conditions or access issues (e.g., too deep, too swift).
    - ***If you move a site:***
        - Make sure that the notes briefly describe your rationale
        - Use an alternative Monitoring Location ID (MLID) from the lists provided by DWQ
        - E-mail the locations sheets with notes explaining the rationale to Jeff ASAP following the run (jostermiller@utah.gov)
2. ***Fill out the site condition data form.***
    -
3. ***Collect water chemistry samples and instantaneous measurements from the data sonde.***
   You'll Need:
   At the stream: unfiltered nutrient bottle, filtered nutrient bottle, BOD transfer bottle, and calibrated sonde.
   At the vehicle: water chemistry data form, geopump, filters (course and fine), sharpie, pencil, and cooler with wet ice.

- ***Fill and label the unfiltered nutrient bottle***. DO NOT OVERFILL, the bottle contains preservative. If you accidentally overfill, discard the bottle and try again. Place the labeled sample on wet ice.
    - ***Note: It is important that the time on the bottle label is the same as the time recorded on the lab sheet.***
- ***Fill the half gallon (BOD) bottle.*** Triple rinse both containers with ambient water.
- ***Prepare the filtered nutrient sample***.
    - Place the end of the geopump tubing into the filled BOD bottle and run ~1/3 of the water through the geopump to thoroughly rinse.
    - Open the filter holder and place the fine filter (grid side up) onto the end that is not attached to the geopump, then place the courser filter on top and reattach to the geopump.
    - Label a filtered nutrient bottle, run a little water through the filters, then carefully fill the bottle (minimum of ¾ full, but only if absolutely necessary due to quickly clogging filters). Again, DO NOT OVERFILL. If the filters become clogged, carefully replace them, discarding the used filters. Place on wet ice.
    -

4. ***Collect Discharge*. You'll need: flow meter, water chemistry data form, pencil, and foot tape.**
    - Find a transect with laminar flow and collect discharge. Record the discharge or if necessary the depth, width and velocity measurements (discharge calculations will be completed later) on the data form.

Attachment 5.4. UDWQ Protocols for Use of Dissolved Oxygen Logger

SCOPE AND APPLICABILITY

Measure high-frequency Dissolved Oxygen (DO) data for use in assessment and standards formulation from lotic and lentic waters of Utah. Dissolved Oxygen refers to the level of free, non-compound oxygen present in water or other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water. In limnology (the study of lakes), dissolved oxygen is an essential factor second only to water itself. A dissolved oxygen level that is too high or too low can harm aquatic life and affect water quality.

SUMMARY OF METHOD

Your miniDOT Logger has arrived completely ready to go. <u>It is set to measure and record time, battery voltage, temperature, oxygen concentration, and measurement quality once every ***15*** minutes and write 1 file of measurements daily</u>. You need only open the miniDOT Logger and switch the Recording Control Switch to the RECORD position. In this condition the miniDOT Logger will record measurements for a year before the internal battery is expended. You must re-close the miniDOT Logger prior to deploying it.

At the end of the deployment period you need only to open the logger and connect it to a host device via USB. The miniDOT Logger will appear as a 'thumb drive'. Your temperature and oxygen concentration measurements, together with a time stamp indicating the time the measurement was made, are recorded in text files in the folder having the serial number of your miniDOT Logger. These files can be copied onto any Windows or Mac host computer.

HEALTH AND SAFETY WARNINGS -- BURSTING HAZARD

Should water enter the miniDOT Logger and come into contact with the enclosed batteries, the batteries may generate gas causing the internal pressure to increase. This gas will likely exit via the same location where the water entered, but not necessarily. The miniDOT Logger is designed to release internal pressure as the end cap is unscrewed, prior to the disengagement of the end cap threads. If internal pressure is suspected, then treat the miniDOT Logger with extreme caution.

CAUTIONS AND DETAILS OF miniDOT

a) Closing and Opening - Close and open miniDOT like you would a flashlight: open by unscrewing the white cylinder from the black end cap. Close by screwing the white cylinder on. When closing, do not tighten the white cylinder. Just screw it on until it makes contact with the black end cap. The logger circuitry is contained in a waterproof housing that must be opened. The housing is opened by unscrewing the white pressure housing from the black end cap, in a way similar to the opening of a flashlight. Turn the pressure housing counter clockwise relative to black end cap. Close by reversing this procedure after being sure that the o-ring is free from debris. Lube o-ring occasionally with grease intended for buna-N o-ring material. Please attempt to handle the miniDOT only by the aluminum chassis, without touching the circuit card. When closing the miniDOT inspect the o-ring and interior of the white cylinder for debris, lube the o-ring, and screw the white cylinder onto the black end cap until the cylinder just touches the end cap**. Do not tighten!** miniDOT tends to get a little tighter during deployment. If you cannot open miniDOT by yourself, find another person with strong hands. This person should grip the black end cap while the other person turns the white cylinder.

b) **Storage When Not in Use** - Remove the batteries. Keep the black end covered with the cap supplied by PME. <u>If the cap is lost, cover the end with aluminum foil. There may be a calibration effect of ambient lighting so attempt to keep ambient light from reaching the sensing foil as much as possible.</u>

c) **Battery replacement –**

***Caution: Improper replacement of the battery will damage the miniDOT Logger.

*** PME recommends Energizer L91 AA size lithium batteries or Duracell AA size alkaline batteries.

***<u>If you install the batteries backwards you should plan to purchase a new miniDOT Logger.</u>

Follow these steps to replace batteries:

1) Move the Logger Control Switch to the Halt position.

2) Remove the depleted batteries noting the position of the (+) terminal.

3) Use only new, fully charged batteries, both of the same type.

4) Install fresh batteries with the (+) position the same as the removed battery.
   The (+) position is also marked on the inside of the battery holder.

5) The miniDOT Logger LED Light should flash to indicate that the software is beginning operation within a second or two after you complete the battery installation. At this time the logger will enter the mode selected by the Logger Control Switch (which should initially be Halt from Step 1).

AA Alkaline Battery Life - Alkaline batteries will give somewhat less performance than lithium, especially at low temperatures. Alkaline batteries are superior to lithium in one way: you can guess how much battery life remains from measurements of the battery terminal voltage. For short deployments of a month or two alkaline batteries will provide adequate performance. For longer deployments, or for deployments in cold environments, substitute lithium batteries.

AA Lithium Battery Life - The miniDOT Logger consumes battery power mostly from the measurement of dissolved oxygen, but also slightly from simply keeping track of time, writing files, sleeping, and other activities. The following table presents the approximate endurance of the miniDOT Logger when powered by the Energizer
L91 AA lithium / ferrous disulfide batteries:

SAMPLE INTERVAL (minutes)	Main AA Battery Life (months)	Number of Samples
1	12	500K
10	>12	>52,000
60	>12	>8,000

Keep a general record of miniDOT Logger number of samples. It is not possible to accurately tell the charge state of a lithium battery from measurements of its terminal voltage. If you have a general idea of the number of samples already obtained on a battery, then you can make a guess as to how many more samples remain.

The numbers in the table above are at the time of this writing are based upon extrapolations of testing of 500K samples acquired at 5 second interval. The 1 year performance at 1 minute is very likely. Performance at longer sample intervals will be much longer but how long is difficult to predict. In any event, these AA batteries are easily available and relatively inexpensive compared to the cost of the miniDOT. PME suggests you replace the batteries often, especially before any long (months) measurement deployment.

Monitor battery terminal voltage. You cannot tell from terminal voltage of a lithium battery how long the battery will last, but you can tell if it will die sometime really soon. The Low Drain Performance plot below gives an estimate of terminal voltage for both lithium and alkaline batteries. Your measured voltage will be 2X what is shown below since there are two batteries in series within the miniDOT. You can operate batteries down to about 2.4 Volts (for two in series, 1.2 Volts on the graph below). Measure the series voltage as shown in the picture below. Your batteries are dead if this measurement is less than 2.4 Volts.

Coin Cell Battery Life - The miniDOT Logger uses a coin cell for backup of the clock when the power is switched off. This coin cell will supply many years of clock operation. Should the coin cell discharge it must be replaced by PME. ***Contact PME.***

INTERFERENCES – BIO-ACCUMULATION, RECALIBRATION, ETC…

Sensor cleaning -The sensor can be cleaned at regular intervals depending on the *fouling* condition (i.e., How nutrient-rich and therefore how much potential for bio-accumulation on sensor window) at the site. The cleaning procedure of the sensor spots should be done with caution so that the protective coating is not removed. If the fouling is calcareous it can normally be dissolved with household vinegar. If the marine growth remains, then use Q-tips to gently wipe it off after it has been softened by soaking in vinegar or perhaps dilute HCl. After cleaning the sensor it should be rinsed well in clean tap water before storing or reuse. Do not use other organic solvents such as acetone, chloroform, toluene since these and others will damage the foil. The sensor membrane can also be cleaned using a 3% H_2O_2 solution or rinsing it with ethanol. The plastic case of the miniDOT Logger can be gently scrubbed.

******* The device needs to be *verified* pre- and post-deployment. Verification checks to validate that the logger is able to correctly measure the specific criteria. To do this a field crew will use an existing sonde to verify/validate the miniDOT's dissolved oxygen (DO) measurements by taking a measurement prior to cleaning and just after. This will be done for both pre- and post-deployment(s).

PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

Field personnel are required to read this SOP annually and acknowledge they have done so via a signature page (see Appendix 1) that will be kept on-file at DWQ along with the official hard copy of this SOP.

Personnel collecting field readings must be familiar with miniDOT verification, calibration and use, safety procedures, proper handling, and record keeping. Monitors are responsible for attending refresher meetings held each spring to review calibration procedures and use.

New staff will be trained in the field by experienced personnel. The procedures discussed in this SOP can change over time as a result of the technological changes being implemented; such information generally is available from
the manufacturer, either online or in an updated user manual or other technical guidance document. Monitors operating miniDOTs must stay current as to how their instrument operates and is maintained.

EQUIPMENT AND SUPPLIES

Removal of the cover reveals the logger connections and controls, shown below.

The LED Light is a LED that can display either red or green light. This is used to indicate different features described in **Section XXXXX** in this SOP.

The Logger Control Switch controls the logger mode:

- **Record** – When the switch is in this position the logger is recording measurements.
- **Halt** – When the switch is in this position the logger is not recording and is sleeping at low power.

LED Indications - The miniDOT Logger indicates its operation with its LED. The table below presents LED indications:

LED	Reason
1 Green Flash	Normal. Presented immediately after new batteries are installed. Indicates that the CPU has started its program.
1 Green Flash	Occurs at the time of sampling for sample intervals of 1 minute or less.
5 Green Flashes	Normal. Indicates that miniDOT is beginning to record measurements. This indication appears in response to switching the Recording Control Switch to *Record*.
5 Red Flashes	Normal. Indicates the miniDOT is ending recording of measurements. This indication appears in response to switching the Recording Control Switch to *Halt*.
Continuously Green	Normal. Indicates the miniDOT is connected to a host device via USB.
Continuously Flashing Red	SD card write error. Try removing/reinstalling batteries. Contact PME.

USB Connection - allows communication between the logger and an external host computer. When connected, the logger is in halt mode regardless of the Logger
Control Switch position. When disconnected the logger mode is controlled by the switch position. The switch position may be changed while the USB is connected.
The User Manual and other software are also recorded on the miniDOTLogger.

- **miniDOTControl** allows you to see the state of the logger as well as set the recording interval.

- **miniDOTPlot** allows you to see plots of the recorded measurements.

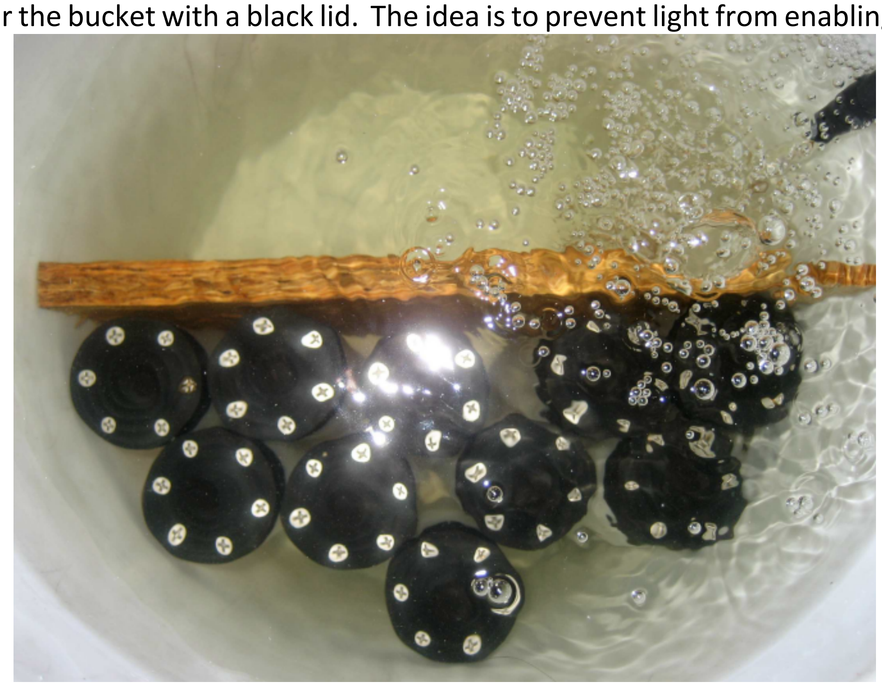
- **miniDOTConcatenate** gathers all the daily files into one CAT.txt file.

Your miniDOT Logger will return to recording measurements after you disconnect the USB connection. If you wish to stop recording, switch the Recording Control Switch to the Halt position. You may switch the Recording Control Switch at any time.

CALIBRATION, VERIFICATION AND SAMPLING PROCEDURES

Instrument Calibration and Verification:

Verification of DO measurement - You may from time to time want to verify the calibration of your miniDOT. Do this by placing the miniDOT in a black 5 gallon bucket containing 4 gallons of fresh water. (The picture below shows a white bucket so that miniDOT's are more easily seen.) The miniDOT sensor end (black) is heavy and the miniDOT will tend to flip so that this end is down. Prevent this somehow. miniDOT must be placed in the bucket with the sensor end upwards. Otherwise bubbles will accumulate in the sensing end and miniDOT will not sense water DO correctly. Use an aquarium pump and air stone in the water to provide a bubble stream. Cover the bucket with a black lid. The idea is to prevent light from enabling algal growth.



Record measurements for several hours or a day but in any event long enough for the miniDOT temperature to come to equilibrium with the water. During the experiment find the local air pressure, either from measurements or from a local weather station. Additionally, use one of the other field sondes, which is calibrated, and record the DO values for future analysis of sensor drift. These measurements can be used during analysis to correct errant data. Watch out... weather stations often report barometric pressure referenced to sea level. **You must determine the absolute barometric pressure at your elevation.**

A *more comprehensive experiment* is to additionally place ice in the bucket, mixing until the water temperature is close to zero degrees and then removing the ice. Place the bucket on a towel or cardboard and cover with a towel. Record for 24 hours as the bucket temperature gradually returns to room temperature.

After recording the bubbled water, you may also remove the air stone and gently mix a packet of baker's yeast into the bucket together with a tablespoon of sugar. The water must be only slightly warm to the touch but not more than 30 C. These organisms will deplete all the dissolved oxygen in the water. Cut a disc of thin plastic film just large enough to lay on top of the water. Place this on top of the water. Do not stir or bubble after placing the film. Record measurements for at least an hour or more.

Use miniDOT plot to examine the measurements. Saturation values should be very close to 100%, depending upon the accuracy that you have determined barometric pressure. If you placed ice in the bucket then saturation values will still be 100% but you will see the DO concentration and temperature change greatly as the bucket warms.

The recorded data when using yeast should show 0% saturation and 0 mg/l dissolved oxygen concentration. In practice miniDOT often reports slightly positive values of about 0.1 mg/l, but within the accuracy of the miniDOT.

Recalibration- The miniDOT Logger will maintain its calibration without the necessity of adjustment by the user. Loggers should be returned to PME for recalibration. We suggest that this be done every ½ million samples. THEREFORE FIELD CREWS WILL FOLLOW FIELD VERIFICATION PROTOCOL BELOW.

Field verification and deployment procedure

This procedure does not recalibrate the logger, rather it identifies pre- and post-deployment DO readings and allows the user to identify drift as the result of bio-fouling as well as a logger that may be compromised resulting in errant data. The procedures below will be conducted at EVERY deployment.

Pre-deployment-

1) Make sure optical field of logger is clean.
2) Using the logger deployment device install logger in relevant section of flowing water and attach the device to rebar on bank (see picture and diagram in Section-Sample Collection).
3) Start the logger by flipping the switch to "record" and note the time and date, logger name, location (use GPS).
4) Connect the logger to a field computer via a USB-2.0 chord and create a folder using the MLID as the title. The logger can be found under "Computer" then under a local disk as "DO_serial number of logger".
5) Once connected to the logger open "miniDOTControl", connect to the logger. Make sure the "Set sample interval" is set to 15 minutes.
6) Deploy the DO logger using the deployment device and make sure it's affixed to the rebar on the bank.
7) Using the field crews handheld *calibrated* sonde (used in water chemistry sampling) record the instantaneous DO and salinity also noting time and date. Additionally, record the elevation. This is imperative for post-deployment correction via miniDOTConcatinate and miniDOTPlot programs.

   -The miniDOT is now deployed and recording continuous DO data

Post-deployment-

1) Retrieve device from location. Be sure to dry off the logger prior to opening vessel and motherboard.
2) Using the handheld sonde measure the instantaneous DO and salinity and record observations.
3) Attach the logger to a computer and navigate to miniDOTPlot.jar and open the program.
4) Once open enter the surface elevation (meters) of the site via the GPS in meters and salinity (ppt-parts per thousand). To compute salinity one can use the handheld sonde. Enter both of these into miniDOTPlot.
5) Rename the folder using this type of file structure: DO_device serial #_date (post-deployment)_MLID.
6) Copy and paste that folder to folder on computer.
7) Next, go the folder for the logger for that site. Open the CAT.txt file and make sure you downloaded the file and it initially looks correct.
8) Next, make sure there are no folders on the logger that have data. Effectively wiping the logger clean of older data. **DO NOT ERASE THE MANUAL.PDF OR ANY OF THE FILES THAT CONTAIN *.JAR AS THESE FILES RUN THE LOGGER.**
9) Turn off the logger by depressing the switch to "Halt".

****To examine the files at a later date copy and paste the *.jar files from an existing unit to the folder with a sites data and open the data.*

Sample Collection-general overview from manufacturer

****This protocol is from the manufacturer's manual and provides an overview. The "verification" description above provides the DWQ protocol.***

Follow these steps to start the deployment, logging DO & T once each 15 minutes AFTER VERIFICATION IS COMPLETED:

1) Open the miniDOT Logger by unscrewing the white housing from the black end cap (it opens like a flashlight). Remove the housing completely. Inside you will see the circuit pictured below:

2) Switch the Logger Control Switch to the Record position. The LED will flash green 5 times. The miniDOT Logger will now record a measurement of time, battery voltage, temperature, and dissolved oxygen every 10 minutes (or at some other interval you may have set using miniDOTControl).

3) Inspect the o-ring seal for debris.

4) Close the miniDOT Logger by screwing the white housing back onto the black end cap.

5) Deploy the miniDOT Logger.

   The logger should be deployed in the "stream retaining device" (see picture below) and will, hopefully, provide refugia for the logger during deployment. The retaining devise will be attached to the stream bed and stream bank via a metal chord to prevent entrainment downstream during a high flow event. The bow of the logger faring should be placed upstream allowing the logger to stay in place in the streams current-flow in orange arrows in photograph below.

Follow these steps to end the deployment:

1) Recover the miniDOT Logger

2) Clean and dry all accessible surfaces except the 'foil'.

3) Open the miniDOT Logger by unscrewing the white housing from the black end cap. Remove the housing completely, taking care that water does not drip onto interior surfaces of circuits or other items inside the logger.

4) Connect to a Windows host computer via USB. miniDOT will appear as a 'thumbdrive'.

5) Copy the folder having the same serial number as the miniDOT Logger (example 7392-0001) to the host computer.

6) (**Suggested, but optional**) Delete measurement folder, but NOT miniDOTControl or the other .jar programs.

7) (**Optionally**) Run the miniDOTControl program to see the state of the miniDOT Logger such as battery voltage or to select a different recording interval.

8) (**Optionally**) Run the miniDOTPLOT program to see a plot of measurements.

9) (**Optionally**) Run the miniDOTConcatenate program to gather together all the daily files of measurements into one CAT.txt file.

10) If no more recording is desired, switch the Recording Control Switch to Halt, otherwise leave it set to Record to begin recording after USB disconnection.

11) Disconnect the miniDOT Logger from the USB connection.

12) Inspect the o-ring seal for debris.

13) Close the miniDOT Logger by screwing the white housing back onto the black end cap.

***Remove the batteries if storing the miniDOT Logger for extended periods.

Recording Interval – The miniDOT Logger measures and records time, battery voltage, temperature, dissolved oxygen concentration and measurement quality at equal time intervals. The default time interval is 10 minutes. However, it is also possible to instruct the miniDOT Logger to record at different intervals. This is accomplished by running the miniDOTControl.jar program supplied with the miniDOT.

Recording intervals must be 1 or more minutes and must be less than or equal to 60 minutes. Intervals outside this range will be rejected by miniDOTControl. (Contact PME for other recording intervals.)

Time – All miniDOT times are UTC (formerly known as Greenwich mean time(GMT)). The miniDOT Logger internal clock will drift in the <10 ppm range (< about 30 seconds/month) so you should plan to connect it occasionally to a host having an internet connection. The miniDOTControl program will automatically set time based on an internet time server.

Please refer to 10.0 Computer Hardware and Software Data and Records Management for instructions on operating the miniDOTControl *program.*

File Information – The miniDOT Logger software creates 1 file daily on miniDOT's internal SD card. The number of measurements in each file will depend upon the sample interval. Files are named by the time of the first measurement within the file based on the logger's internal clock and expressed in YYYY-MM-DD HHMMSSZ.txt format. For example a file having the first measurement on September 9, 2014 at 17:39:00 UTC will be named 2014-09-09 173900Z.txt.

Files can be uploaded from miniDOT by connecting miniDOT to a host computer and by using the host computer to copy/paste the files from miniDOT to some host computer storage.

Each measurement within files has a time stamp. The time stamp format is Unix Epoch 1970, the number of seconds that have passed since the first moment of1970. This may be inconvenient in some cases. If so, the miniDOTConcatenate software not only concatenates all the measurement files but also adds more readable statements of the time stamp.

Please refer to 13.0 Computer Hardware and Software Data and Records Management for instructions on operating the miniDOTConcatenate program.

miniDOT requires time and battery energy to work through the file directory on SD card to allocate new file space. A few hundred files on SD is not a problem but as the number of files grows large into the thousands miniDOT may suffer decreased battery life or other performance problems. Please, at the earliest convenient time, copy recorded files to a host computer and delete them from miniDOT. Also, do not use miniDOT to store files unrelated to miniDOT operation.

Computer Hardware and Software Data and Records Management

The miniDOT arrives with these files:

a) **MiniDOTControl.jar** allows you to see the state of the logger as well as set the recording interval.
b) **MiniDOTPlot.jar** allows you to see plots of the recorded measurements.
c) **MiniDOTConcatenate.jar** gathers all the daily files into one CAT.txt file.
d) **Manual.pdf** this manual.

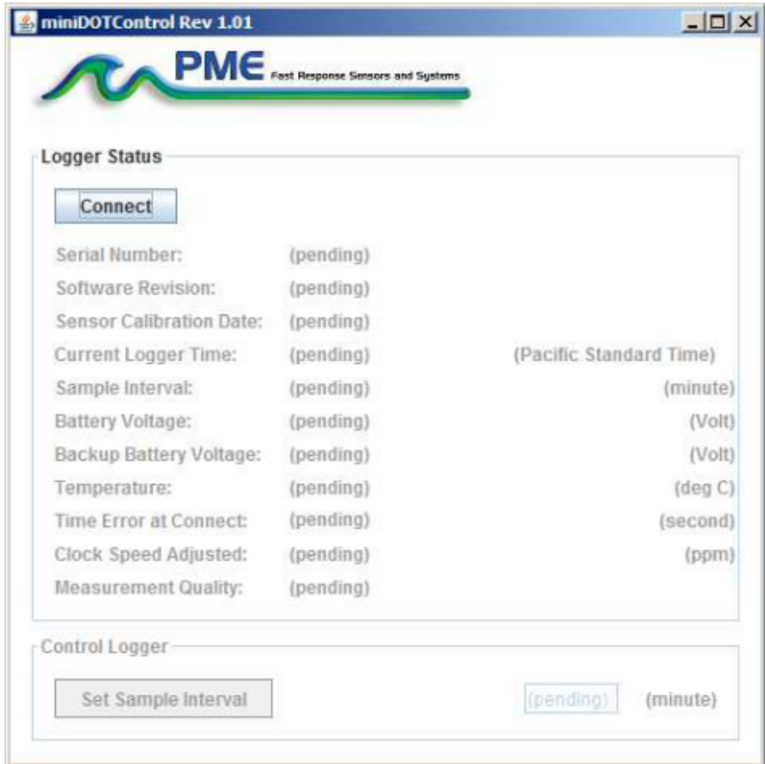
These files are located on the root directory of the miniDOT. PME suggests you leave these programs where they are on the miniDOT, but you may copy them to any folder on your computer's hard drive. MiniDOTControl, miniDOTPlot, and miniDOTConcatenate are Java language programs that require the host computer to have the Java Runtime Engine V1.7 (JRE) or later installed. This engine is commonly required for internet applications and will likely already be installed on the host computer. You can test this by running miniDOTPlot. If this program displays its graphical user interface then the JRE is installed. If not then the JRE can be downloaded via internet from

http://www.java.com/en/download/windows_xpi.jsp

At this time miniDOT Logger is supported on Windows operating systems, but may also operate on Macintosh and perhaps Linux.

miniDOTControl

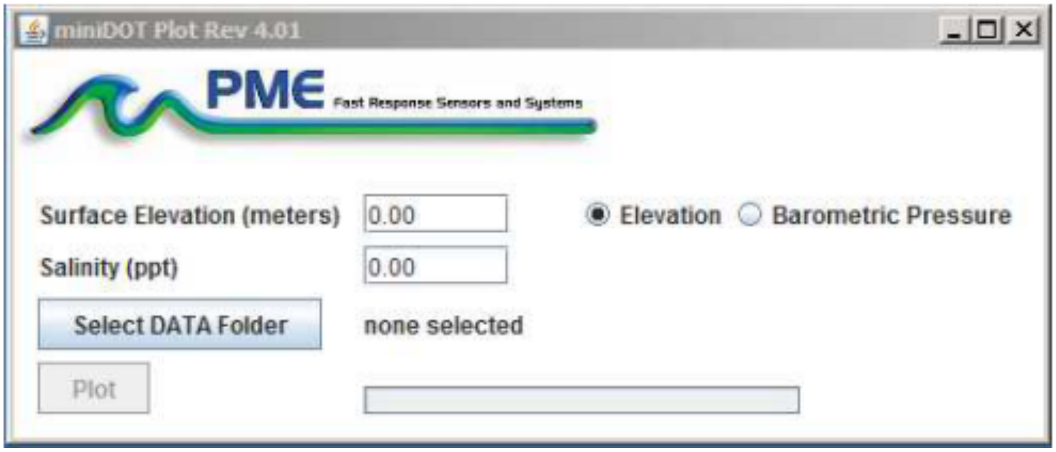
Begin program operation by clicking on miniDOTControl.jar. Software presents the screen shown below:



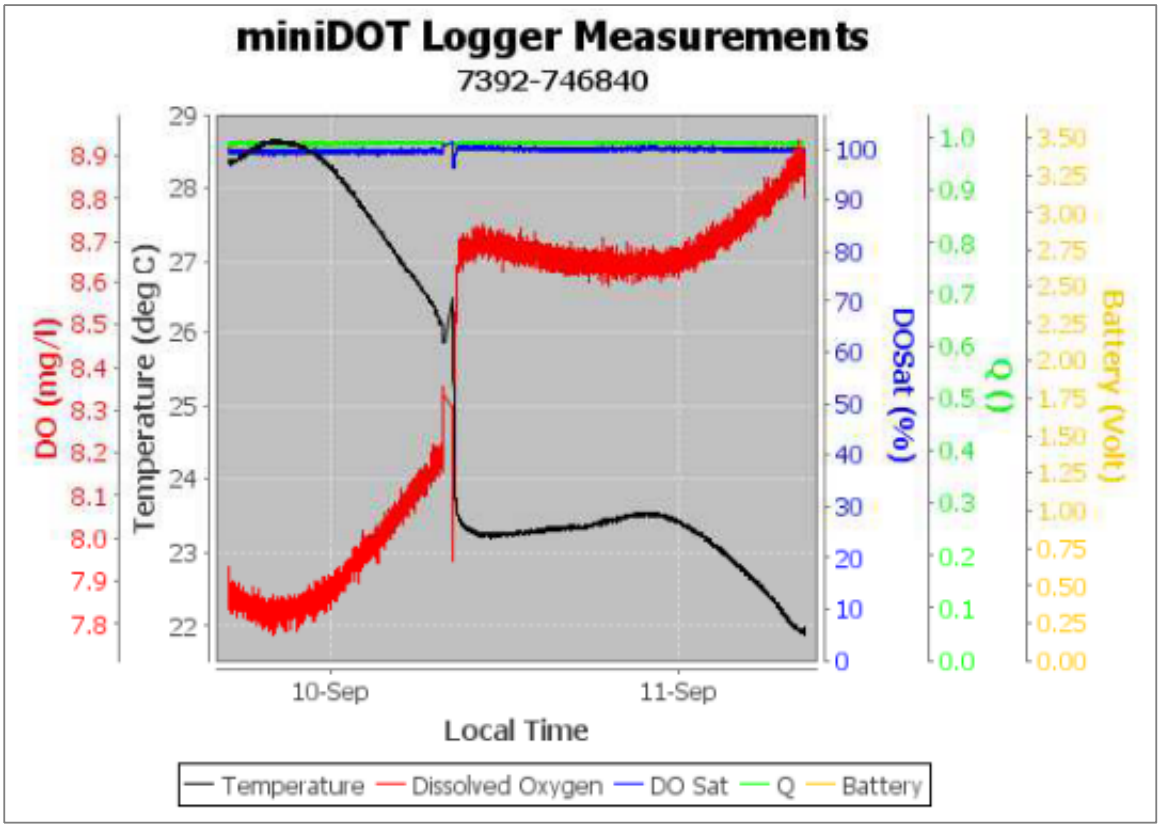
The miniDOT must be connected to USB at this time. When correctly connected the miniDOT LED will display a constant green light. Click the Connect button - The software will contact the logger. If the connection is successful the button will turn green and display "Connected". The Serial Number and other parameters will be filled in from information taken from the miniDOT. If the host computer is connected to the internet, the current difference between an internet time server's time and the miniDOT Logger internal clock will be displayed. And, if more than a week has passed since time was last set, the miniDOT clock will be set and check mark icon will appear. If the host computer is not connected to the internet no time services will occur. The current miniDOT Logger sample interval will be displayed next to the Set Sample Interval button. If this interval is acceptable the interval need not be set. To set the interval, enter an interval not less than 1 minute and not greater than 60 minutes. Click the Set Sample Interval button. Shorter and faster intervals are available. Contact PME. End miniDOTControl by closing the window. Unplug miniDOT USB connection. Upon disconnection of the USB cable the miniDOT will begin logging or remain halted as indicated by the position of the Logger Control Switch.

miniDOTPlot

Begin program operation by clicking on miniDOTPlot.jar. Software presents the screen shown below.



miniDOTPlot plots the files recorded by the miniDOT Logger. The software reads all miniDOT files in a folder, except the CAT.txt file. The software will also compute oxygen saturation from dissolved oxygen measurements. To do this software must know the air pressure and salinity. It calculates air pressure based on elevation of the water surface above sea level or uses the barometric pressure you enter if Barometric Pressure is selected. If Elevation is entered, no compensation for weather-induced barometric pressure variation is made. Enter elevation or barometric pressure. Enter water salinity. Select the folder that contains the files recorded by miniDOT. If miniDOTPlot is run directly from the miniDOT the program will suggest the folder located on the miniDOT SD card. You may accept this by clicking on Process, or you may click on Select Data Folder to browse to your computer's hard drive. If the number of measurements recorded is small, say a few thousand, these can conveniently be plotted directly from miniDOT storage. However it is best to copy large measurement sets to the host computer and select them there since file access to miniDOT is slow. miniDOT measurement folders must NOT contain any files besides those miniDOT records and the CAT.txt file. Press Plot to begin plotting. The software reads all miniDOT Logger data files in the selected folder. It concatenates these and presents the plot shown below:

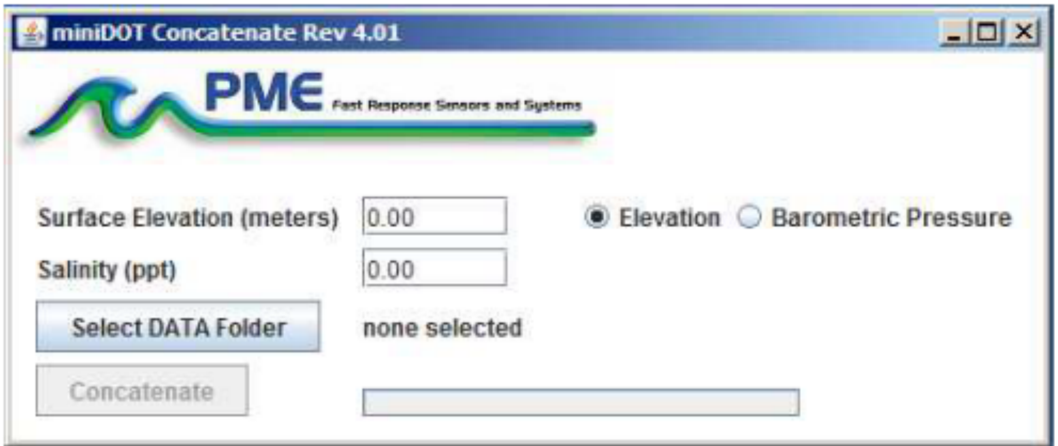


You may zoom this plot by drawing a square from upper left to lower right (click and hold left mouse button) that defines the zoom region. To zoom completely out, attempt to draw a square from lower right to upper left. Right click on the plot for options such as copy and print. The plot can be scrolled with the mouse while the Control key is held depressed. Copies of the plot can be obtained by right clicking on the plot and selecting Copy from the pop-up menu. Different DATA Folders can be selected during one session of the program. In this case the software produces multiple plots. Unfortunately the plots are presented exactly on top of each other and so when a new plot appears it is not obvious that the old plot is still there. It is. Just move the new plot to see it. The software can be re-run at any time. If an already processed DATA Folder is selected the software simply reads the miniDOT Logger measurement files again. End miniDOTPlot by closing the window.

Special note: plotting of sample sets of more than 200K samples may consume all memory available to the JRE. miniDOTPlot will present a partial plot and freeze in this case. A simple solution is to separate the files into multiple folders and plot each folder individually. A special miniDOTPlot that sub-samples can be provided by PME. Please contact PME in this case.

miniDOTConcatenate

Begin program operation by clicking on miniDOTConcatenate.jar. Software presents the screen shown below.



miniDOTConcatenate reads and concatenates the files recorded by the miniDOTLogger. Software produces CAT.txt in the same folder as selected for the data.CAT.txt contains all the original measurements and contains two additional statements of time and oxygen saturation. To compute saturation, software must know the air pressure and salinity. It calculates air pressure based on elevation of the water surface above sea level or uses the barometric pressure you enter if Barometric Pressure is selected. If Elevation is entered, no compensation for weather-induced barometric pressure variation is made. Enter elevation or barometric pressure. Enter water salinity. Select the folder that contains the files recorded by miniDOT. If miniDOTPlot is run directly from the miniDOT the program will suggest the folder located on the miniDOT. You may accept this by clicking on Process, or you may click on Select Data Folder to browse to your computer's hard drive. If the number of measurements recorded is small, say a few thousand, these can conveniently be plotted directly from miniDOT storage. However it is best to copy large measurement sets to the host computer and select them there since file access to miniDOT is slow. miniDOT measurement folders must NOT contain any files besides those miniDOT records and the CAT.txt file. Press Concatenate to begin concatenating files and create the CAT.txt file. The CAT.txt file will resemble the following:

```
MiniDOT Logger Concatenated Data File
Sensor:              7392-0002
Concatenation Date: 2014Jun30 10:20:40 PDT

DO concentration compensated for salinity: 0.0 (ppt)
Saturation computed at elevation: 0.0 (meter)

                Unix Timestamp,             UTC_Date_&_Time,         Pacific Standard Time,        Battery,
                      (Second),                      (none),                        (none),         (Volt),
                    1402942957,         2014-06-16 18:22:37,           2014-06-16 11:22:37,       3.310000,
                    1402942959,         2014-06-16 18:22:39,           2014-06-16 11:22:39,       3.320000,
                    1402942961,         2014-06-16 18:22:41,           2014-06-16 11:22:41,       3.320000,
                    1402942963,         2014-06-16 18:22:43,           2014-06-16 11:22:43,       3.320000,
```

QUALITY ASSURANCE AND QUALITY CONTROL

miniDOTs must be verified before use and verification (and reverification) must be documented as described in this SOP and other project-specific documentation.

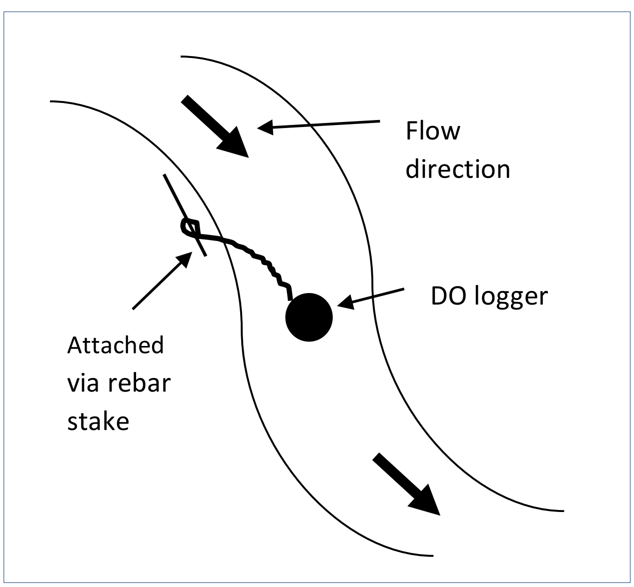
Project-specific quality assurance and quality control requirements are described in project-specific Sampling and Analysis Plans (SAPs) and should be communicated to the field team by the Project Manager.

Representative water-quality data is to be collected, according to the sampling conditions required under the project-specific SAP. miniDOT operators should not alter designated sampling locations or times unless otherwise directed by a project manager. If hydrologic conditions are significantly different from those targeted in the SAP, operators should contact the project manager for further instructions. Operators should record in field notes any site conditions that may lead to an unrepresentative field reading and should take site photographs to record these observations.

REFERENCES

Precision Measurement Engineering 2014, miniDOT-User Manual., www.PME.com Pgs. 1-21.

APPENDIX



Attachment 5.5. UDWQ Protocols for Macroinvertebrate Collection

SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for the collection of aquatic benthic macroinvertebrates (BMI) within running waters (rivers and streams). Benthic macroinvertebrates are also commonly referred to as benthos, inverts, macroinverts, macroinvertebrates, or simply "bugs". Collection of BMI is routinely performed during DWQ's probabilistic state-wide surveys; for those procedures, please refer to the specific instructions found in the Utah Comprehensive Assessment of Stream Ecosystems (UCASE) Field Manual (http://www.waterquality.utah.gov/ Monitoring/WQMonitorQAQC.html). There are, however, numerous additional opportunities to collect BMI data for streams outside of the probabilistic survey design. BMI data is desirable because:

1) BMI are relatively quick and inexpensive indicators for identifying a wide variety of pollutants

2) BMI typically exhibit a predictable community composition under natural conditions

3) BMI are a temporally-integrated water quality indicator versus water chemistry samples (which are essentially a snapshot of current conditions)

4) Some BMI are especially useful for targeted sampling due to their high sensitivity to environmental changes (e.g., impacts of remediation or pollutant discharges)

DWQ's collection methods are derived from USEPA's Environmental Monitoring Assessment Program-Western Pilot program (EMAP-West), which provides continuity and consistency for DWQ and other agencies conducting water quality assessments using BMI.

This SOP is applicable to rivers and streams. For collection of BMI in wetlands, refer to DWQ's SOP for Collection of Macroinvertebrates in Wetlands.

IMPORTANT: If BMI samples are intended for regulatory purposes by outside (non-DWQ) entities, samples must be analyzed by an accredited laboratory with documented QA/QC and analytical procedures approved by DWQ. Please first contact DWQ for questions about specific details.

SUMMARY OF METHOD

Because biological measures require sampling an extended length of waterway for a representative picture of the ecological community, a reach length of 40 times the channel wetted width (at base flow) is established to characterize the habitat and several biotic assemblages associated within the sampling reach. Riffle habitat is targeted when sampling running waters because of greater BMI diversity, ease of collection, and consistency. However, if a site is devoid of riffles, then edge habitat is targeted.

The collection technique consists of a semi-quantitative benthic macroinvertebrate composite sample using a D-frame net. A composite sample is performed by collecting 8 subsamples made at different locations within the reach. The sampler carries a sieve bucket as they move through the reach and composites the benthic material collected in the D-net at each subsample location into the sieve bucket. The BMI collection technique itself is designed to be rapid so that one subsample requires no more than 3 minutes to perform. At each of the 8 subsample locations, the sampler attempts to collect all available BMIs located in a one square-foot area upstream of the D-net opening. BMI are collected from the largest substrates down to the smaller substrate to a depth of approximately 3 inches. The sampler rinses the material to the bottom of the net and then empties the contents of the net into the sieve bucket. This process is repeated at the remaining seven subsample locations. The result is a composite BMI sample in the sieve bucket.

Sample processing is required for the composite sample because most of the heavy inorganic benthic material collected is not of interest and the BMI in the sample must be concentrated into small jars for transfer to the analytical laboratory. Processing involves using a regular 2.5 gallon bucket and water to separate out heavy inorganic material from lighter organic material (where the BMI are most likely located). This separation process results in a much smaller volume of material which is then placed into 1 L plastic jars and preserved with 95% ethanol. Multiple jars may be required for one sample. Jars are then sealed, labeled, and stored until delivery to the laboratory.

Field data and other sampling details during BMI collection is recorded on a Sample Collection Form. Numerous data are documented including GPS waypoints of the site location, a sketch of the targeted sampling stream reach including the subsample locations, and identification and description of the sampled habitat.

Lastly, personal gear and sampling equipment is decontaminated prior to leaving the site to reduce the spread of invasive species. See DWQ's SOP for Decontamination of Monitoring Equipment.

DEFINITIONS

BMI: benthic macroinvertebrates

ft^2: square foot

L: liter

mm: millimeter

MSDS: Material Safety Data Sheet

QA/QC: Qualty Control and Quality Assurance

µm: micrometer

HEALTH AND SAFETY WARNINGS

Field personnel should be aware that hazardous conditions potentially exist at every waterbody. If unfavorable conditions are present at the time of sample collection, it is recommended that the sample collection be rescheduled. If hazardous conditions arise during sampling, such as lightning, high winds, rising water, or flash flood warning, personnel should cease sampling and move to a safe location.

Field personnel should take appropriate precautions when operating equipment and working on, in, or around water, as well as possibly steep and unconsolidated banks, or edges of ponds/lagoons. All field crews should follow EPA, OSHA, and specific health and safety procedures and be equipped with safety equipment such as proper wading gear, personal flotation devices (PFDs), gloves, first aid kits, cellular phone, etc.

Be sure to wash hands or use hand sanitizer after sampling, especially when sampling sites with potential fecal contamination.

Prior to sampling be sure to review the MSDS for the preservation chemical. Pure ethanol (200-proof, 95% ethyl alcohol) is preferred for sample preservation. However, denatured alcohol may be used with caution. Wear gloves and wash off any denatured alcohol that comes in contact with skin. Denatured alcohol contains hazardous components and should not be inhaled, ingested, or come into contact with skin.

Alcohol is flammable. Keep alcohol carboy away from heat, sparks, flame, and all other sources of ignition. Do not smoke in the vicinity of alcohol or fumes.

CAUTIONS

For representative data, it is best to collect BMIs during the growing season, which can vary depending on elevation and latitude, but is generally limited to the months of May through October.

Refer to all instructions within this SOP for setting up the sampling reach and targeting the proper sample habitat in order to collect a representative sample.

INTERFERENCES

Field personnel should scout the potential sampling reach to make sure it is clear of obstacles that would prohibit sampling and data collection activities. Make every effort to avoid walking within the proposed stream reach during reconnaissance to ensure biological organisms remain unaffected.

Samples must be collected in the appropriate sample containers with the appropriate preservative; failure to preserve a sample properly can lead to inaccurate results, sample degradation, or invalidation of the sample by the laboratory.

Samples must be stored and handled appropriately; samples stored improperly may be invalidated by the laboratory.

Ensure preservative is adequately mixed within the sample. If the sample is not properly preserved, microbes will persist and ultimately destroy the sample. Additionally, ensure the samples are submitted to the laboratory no later than 6 months after collection to reduce likelihood of sample decomposition.

PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

Collection of BMI is a very hands-on technique and requires in-person training from an experienced sampler. Personnel performing water sampling must be familiar with sampling techniques, safety procedures, proper handling, and record keeping.

Samplers are required to read this SOP annually and acknowledge they have done so via a signature page that will be kept on-file at DWQ along with the official hard copy of this SOP.

EQUIPMENT AND SUPPLIES

The following are required for benthic macroinvertebrate collection at wadeable sites:

For collecting samples	• Flagging for marking reach boundary • Kick net (D-frame with 500 µm mesh) with at least a 4-foot long handle or a modified surber with at least a 4-foot long handle. • Watch with timer or stopwatch • Plastic buckets (8-10 quart size) • Sieve bucket with 500 µm mesh openings • Plastic forceps • Wash bottle; 1 Liter capacity labeled “Stream water” • Sample jars suitable for use with ethanol such as 1-Liter HDPE Nalgene sample bottles • 95% ethanol (ETOH) in proper container • Bottle caddy • Electrical tape • Scissors or knife • This SOP or UCASE Field Manual • Waterproof neoprene gloves • Waders, boots, personal flotation device (Use waders with attached boots whenever possible, as opposed to stocking foot waders with separate boots, as organisms can easily get trapped in laces and inside of boots. In addition, it is preferred that personnel do not use boots with felt soles.)
For recording measurements	• Sample Labels (**Figure 2. Example of a properly filled-out sample label.** Template location is U:\WQ\PERMITS\MONITORS\Labels\UCASE Labels) – labels for jar interior must be printed on waterproof paper and filled out in pencil; labels for jar exterior can be printed on regular paper and filled out in ink/sharpie

	• Lead pencils • Fine tipped indelible markers • Clipboard, Sample Collection Form (Error! Reference source not found.) and notebook • Clear tape strips to cover sample labels

PROCEDURE

Pre-Sampling Preparation

Prior to visiting a site, inspect the D-net/modified surber and sieve bucket for holes or tears and replace or repair. It is also good practice to carry a back-up set.

At the site, find an area downstream of the reach and wash all equipment with stream water. Visually inspect the nets and buckets and make sure no particles are present on/inside of them. If they are, continue to wash the gear until it is clean. Rinse out the spray bottle and fill it with stream water.

Setting up the Sampling Reach

At the sampling location, record the channel width at various points to determine the average wetted width, and then calculate the reach length by multiplying 40 times the average channel wetted width (during base flow). Mark each end of the reach using stakes/flags.

While within the boundary of the reach (preferably mid-reach), collect and record GPS coordinates (in decimal degrees). Record these coordinates on the Sample Collection Form (Error! Reference source not found.).

Complete a rough sketch map of the sampled stream reach. Be sure to note any interesting features or landmarks/directions that can be used to find the reach for future visits, in addition to the GPS coordinates.

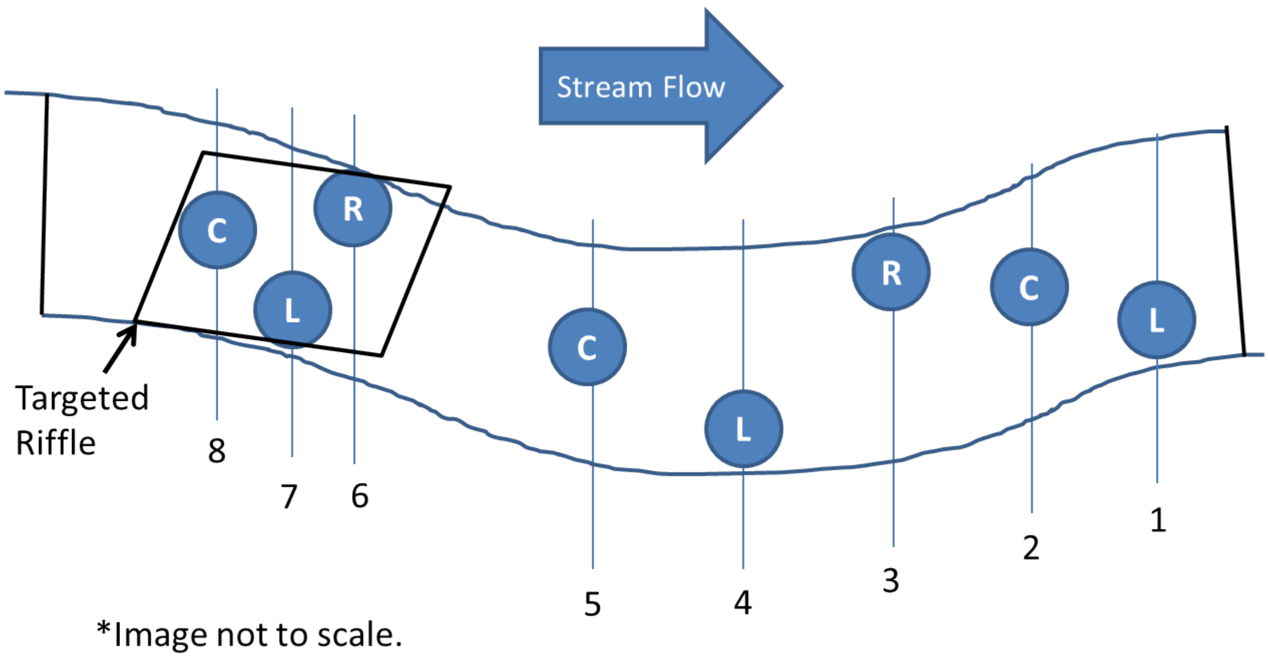
Sample Collection

NOTE: Determining where to collect subsamples within the reach is a somewhat subjective process based on the experience and best judgment of the sampler. Therefore, it is imperative that new samplers first be trained in the field by experienced samplers.

- Gather the clipboard and Sample Collection Form, stopwatch, D-net, and sieve bucket. A scratch piece of paper can be used to record information as well if it is easier to manage; transfer the data later onto the field form, preferably before leaving the field site.

- Begin walking upstream along the reach. While walking along the reach, look for desirable habitat, which are riffle/runs with coarse substrates (coarse gravel or bigger). Your goal will be to collect 8 subsamples within the reach, targeting riffle habitat. In order to reduce human bias, alternating locations in the stream should be sampled (e.g. left-25% of channel width, center- 50% of channel width, right- 75% channel width). Start randomly with one of these locations, and then consistently follow the pattern of left (L), center (C), right (R) and repeat until 8 subsamples are collected (see **Figure 1. Sampling locations within a reach.** as an example). ***Multiple sub-samples can be collected in one riffle habitat if riffle habitat in the reach is limited.***

Figure 1. Sampling locations within a reach.



- At each of the 8 collection points in the reach, determine habitat type (pool, glide, riffle, or rapid), and the dominant substrate (fines/sand, gravel, coarse, or other). On the Sample Collection Form use the box titled "Other" to include sample site information such as occurrence of wood, leaves, edge habitat, overhanging vegetation, bedrock, hardpan, etc. At each subsample location, target coarse substrates such as large gravel (pea-size and larger) to small boulders (basketball-size and smaller) rather than substrates at either spectrum. If coarse substrates are lacking, woody debris, macrophytes, or leaf packs could be targeted; please, identify and document these situations.

- Follow the sample collection instructions specific to habitat type as listed in **Sections 0.0 (Riffle/Run Habitat)** and **0.0 (Edge and Pool/Glide Habitat)**.

NOTE: Sampling edge habitat along the stream banks provides the best alternative to riffle samples (due to BMI diversity, ease of collection and consistency). Often, overhanging vegetation, sticks, and other material will offer protection and stability for BMI to colonize. In many cases, Utah streams will lack or be absent of riffles and coarse sediments (e.g. desert streams in Southern Utah are predominantly characterized by glides and fine/sandy sediments). It is important to target edge habitat in these cases to get a representative BMI sample.

- **<u>Procedures for Riffle/Run Habitats</u>**:

1) With the net opening facing upstream, quickly and firmly position the net securely in the stream bottom to eliminate gaps under the frame. This will ensure flow space is limited (i.e. flow is directed into the net, not under). Avoid large rocks that prevent the net from sitting properly on the stream bottom.

   NOTE: This is easier said than done in most cases, especially in high gradient cobble-dominated streams. Do the best you can and make an attempt to get this net as flush with the substrates as possible. If there are issues or concerns, record them on the Sample Collection Form.

2) Holding the net in position on the substrate, visually define an area that is one net-width wide and one net-width long upstream of the net opening. The area within this quadrat is 1ft^2. Your goal is to collect all available BMIs located in this one square-foot area upstream of the net opening. It is helpful to hold the net in place with your knee while using your hands to disturb the substrate.

3) Check the quadrat for heavy organisms, such as mussels and snails. Remove these organisms by hand and place them into the sieve bucket. Pick up loose rocks or larger substrate particles in the quadrat. Use your hands to dislodge organisms from their surfaces and wash them into the net. When lifting and washing, ensure that the substrate remains in front of the net opening and flows are directed into the net. Scrub all rocks that are golf ball-sized or larger and which are halfway into the quadrat. Discard scrubbed rocks/substrate back into the stream outside of your targeted quadrat.

4) When all large (>golf-ball size) substrates are removed from the area in front of the net, focus on the smaller substrate to a depth of approximately 3 inches. Hold the net securely. Start at the upstream end of the quadrat, and vigorously perturb the remaining finer substrate within the quadrat for 30 seconds (use a stopwatch if desired) with your hands. If the substrate is too difficult to dislodge or the water depth is greater than your elbow, use your boots to disturb the area. Conduct this perturbation activity for no more than 30 seconds. Immerse the net in the stream several times to remove fine sediments and to concentrate organisms at the end of the net. Avoid having any water or material enter the mouth of the net during this operation (dip the net material only, not the mouth). Empty the contents of the net into the sieve bucket and repeat seven more

times as you move upstream. Alternatively, you do not need to empty the net if it has only very little material at this point.

NOTE: For samples located within dense beds of long, filamentous aquatic vegetation (e.g. algae or moss), kicking within the quadrat may not be sufficient to dislodge organisms in the vegetation. Usually these types of vegetation are lying flat against the substrate due to current. Use a knife or scissors to remove only the vegetation that lies within the quadrat (i.e. not entire strands that are rooted within the quadrat) and place it into the net.

NOTE: If flow is too little or slow to sweep organisms into the kick net, stir up the substrate with your hands and sweep the water through the fixed net.

5) Go to the next area with sampleable habitat.

- **<u>Procedures for Edge-Pool/Glide Habitats:</u>**

NOTE: Sample edge habitat if you are at a site where beaver ponds are common or the site lacks desireable habitat (e.g. riffles, coarse substrates).

NOTE: This technique takes practice and beginners should be trained in the field by experienced personnel.

1) Visually define a quadrat that is one net-width wide and one net-width long at the sampling point (1 ft^2).

2) Sweep the area in a figure eight motion with the net for 30 seconds. Or, stir up any overhanging vegetation, sticks, or other material with your hands or feet and then sweeping them in a figure eight motion for 30 seconds. Be sure not to constantly drag the frame of the net against the bed of the stream as you will scoop up lots of fines and muck. Bounce the end of the sample frame on the bottom of the substrate as you sweep the net about 1 inch above the substrate.

3) After 30 seconds, remove the net from the water with a quick upstream motion to wash the organisms to the bottom of the net.

- **<u>General Procedures for Any Habitat Type</u>**

1) If the net is not full after collection of a subsample, move onto the next sampling location and make your next kick, leaving any material from the previous kick in the net. If the net is full of detritus and/or substrates, invert the net to transfer the sample into the sieve bucket. To prevent bugs from being damaged during transport in the bucket, any large substrates need to be removed. To do this, carefully inspect coarse substrates and wash off any organisms still clinging into the bucket (using stream water) before discarding the substrate.

2) Determine the predominant substrate size/type you sampled within the sampling quadrat. Fill in the approprate circle for the dominant substrate type for the transect on the Sample Collection Form. If carrying a clipboard and the data sheets is too cumbersome, you can keep record data in a small notebook or scratch piece of paper and transfer it to the actual data sheet when you are finished, preferably before leaving the field site.

NOTE: If there are co-dominant substrate types, you may fill in more than one circle; note the co-dominants in the comments section of the form.

- **F**ine/sand: not gritty (silt/clay/muck <0.06 mm diam.) to gritty, up to lady bug-sized (2 mm)
- **G**ravel: fine to coarse gravel (ladybug to tennis ball-sized; 2 mm to 64 mm)
- **C**oarse: cobble to boulder (tennis ball to car-sized; 64 mm to 4000 mm)
- **O**ther: bedrock (larger than car-sized; >4000 mm), hardpan (firm, consolidated fine substrate), wood of any size, aquatic vegetation, etc. Note type of “other” substrate in comments on field form.

3) Identify the habitat type where the sampling quadrat was located. Fill in the appropriate circle for channel habitat type for the transect on the Sample Collection Form.

- **P**ool; still water; low velocity; smooth, glassy surface; usually deep compared to other parts of the channel.
- **GL**ide: water moving slowly, with smooth, unbroken surface; low turbulence.
- **RI**ffle: water moving, with small ripples, waves, and eddies; waves not breaking and surface tension is not broken; “babbling” or “gurgling” sound.
- **RA**pid: water movement is rapid and turbulent; surface with intermittent “white water” with breaking waves; continuous rushing sound.

Sample Processing and Preservation

1) After sampling is complete, it is beneficial to separate the organic material from the heavier, inorganic material in the sieve bucket. Gently, dump the composited material from the net/sieve bucket into a plastic bucket (non-sieve); do not worry about removing *all* the material from the sieve bucket. Inspect the net for any remaining bugs that may still be clinging to it. Using a wash bottle full of stream water and/or forceps, flush/pick them off the net and into the bucket.

2) Next, fill the plastic bucket with stream water a few inches above the material line. Slowly swirl the contents in the bucket for about 7 seconds so that lighter (organic) material (sticks, leaves, organisms) in the bucket come to the surface and heavier material (inorganic substrates) stay at the bottom. While the material in the bucket is suspended and swirling, slowly pour the water into the sieve bucket making sure not to dump any of the heavier

material at the bottom of the bucket with it. Repeat this step several times until no more bugs are seen crawling around in the plastic bucket. This process is known as sieving.

NOTE: If there is an abundance of pebbles or cobbles in your sample, you will need to rinse (scrub if necessary) these off in the bucket with ample amount of site water and then discard them.

NOTE: Do not attempt to sieve samples with an abundance of filamentous algae. If this is the case, simply include all of the algae into the sample jar since it is difficult to effectively process these kinds of samples in the field.

3) Ultimately, you will end up with a 2.5 gallon plastic bucket containing coarse gravel and sand, and a sieve bucket containing organisms and detritus (it is okay if some fine sediments are present in the sieve bucket). Be sure to inspect the bucket for caddisfly cases as sometimes the cases are composed of predominantly gravel-sized material. Once the sieving process is complete, you can dump the heavy material left in the 2.5 gallon bucket into the stream or on the ground.

4) Place the material in the sieve bucket into a 1-L jar making sure not to fill it more than 40% full with sample material; use multiple jars if necessary. Be sure not to grab such a large handful where material will become dislodged on the mouth of the bottle when you are filling it. Keep in mind some material will stick to your hands during each transfer. It is a good idea to rinse your hands in the sieve bucket each time you put material in a jar.

5) As the volume of material becomes less abundant at the bottom of the sieve bucket you will need to wash the remaining contents to one side of the bucket in order to get the rest of the sample by gently agitating the bottom outside portion of it.

6) Once you think you have removed everything from of the sieve bucket, carefully examine it for any remaining organisms. If there are still visible organisms use a pair of forceps to pick the bugs out. Or, alternatively, you can tip the sieve bucket upside down and spray the bottom side of it with rinse water into a funnel place in the mouth of the sample jar, washing the BMI in to the jar.

NOTE: If you choose to spray the sieve bucket as a final precaution, but end up filling the sample jar with too much water (>1/3 full) pour it off into the sieve bucket and re-spray with a smaller volume of water.

7) Place a properly and completely filled out sample label (**Figure 2. Example of a properly filled-out sample label.** Template location is U:\WQ\PERMITS\MONITORS\Labels\UCASE Labels) inside each jar (each label for the site should be filled out exactly the same except for the Jar # of total Jars, e.g., Jar 1 of 3). *Labels to be placed **inside** the jar must be printed on waterproof paper and filled out by hand using a pencil. Ink will fade eventually due to the ethanol.*

Figure 2. Example of a properly filled-out sample label. Template location is U:\WQ\PERMITS\MONITORS\Labels\UCASE Labels

BENTHOS COMPOSITE SAMPLE (95% ETOH)

Site Name: CALF CK BL LOWER FALLS

5994070 1 1

EO, HH 2/29/2012

D-net; 8 subsamples

8) Completely fill the jar with 95% ethanol (no headspace). It is very important that sufficient ethanol be used or the organisms will not be properly preserved. Existing water in the jar should not dilute the concentration of ethanol below 70%.

NOTE: Samples can be transported back to the vehicle before adding ethanol if necessary. However, if site is a fair distance from vehicle (e.g. long hike into site) a liter of ethanol should be taken to the site with you. Fill the bottles to at least the detritus line, then completely fill the rest of the bottle once back at the vehicle.

9) Replace the cap on each jar. Slowly tip the jar to a horizontal position and then gently rotate the jar to mix the preservative. Do not shake the jar. After mixing, seal each jar lid with electrical tape.

10) Place a sample label (**Figure 2. Example of a properly filled-out sample label.** Template location is U:\WQ\PERMITS\MONITORS\Labels\UCASE Labels) on the outside of each jar making sure it coincides with the interior label. Cover it with clear tape to maintain label integrity. *Labels to be placed on the **outside** of the jar may be printed on regular paper and partially filled out with ink/sharpie prior to sampling.*

11) Store filled jars in an empty cooler or jar tote during transportation until they can be stored in the appropriate location before shipment to a lab. Samples do not need to be refrigerated or stored on ice.

Reducing the Spread of Invasive Species

Before leaving the site, sampling equipment and personal gear (boots, waders, etc.) need to be thoroughly decontaminated in order to prevent the spread of aquatic invasive species. Refer the DWQ's SOP for Decontamination of Monitoring Equipment for full instructions.

Briefly:

1) Before leaving the site, use a -bristled brush to remove mud, plant material, and debris from boots, nets, and any other monitoring gear that has come in contact with the stream.

2) Remove wading gear immediately after exiting the stream and make sure gear does not come in contact with other equipment. If you use separate wading boots, remove the insoles from the boots (these procedures also apply if wet-wading in shoes or sandals).

3) It is recommended that you wear latex gloves and eye protection when using Sparquat 256. This product is an industrial cleaner and standard safety precautions should be followed.

4) Place waders, boots and insoles, sandals, etc. and any other sampling equipment that has come in contact with the stream into the Sparquat 256 solution for a minimum of 10-15 minutes (the solution may be reused several times).

5) Remove the gear from solution and inspect it to make sure all organisms have been removed.

6) Rinse by immersing and agitating the gear in the bucket of clean rinse water (tap water). Do not use stream water to rinse gear as this may reintroduce organisms.

7) Do not discard the Sparquat 256 solution or the rinse water in the field; dispose of the liquid down a drain that is routed to a wastewater treatment plant.

DATA AND RECORDS MANAGEMENT

Be sure that sample labels both inside and outside the jar are filled out exactly the same. If your sample is placed in multiple jars, be sure to note the number of jars on the labels (e.g., 1 of 2, 2 of 2) as well as on the Sample Collection Form. Be sure that site information [Monitoring Location ID (i.e. site code) if applicable, site description, and GPS coordinates in decimal degrees] are recorded accurately on the Sample Collection Form. Fill out the Sample Collection Form completely. Include subsample dominant substrate type and size, channel characteristics, and other details discussed throughout this SOP. Include with the Sample Collection Form a rough sketch of the sampled reach, ideally including the locations of the 8 subsamples.

QUALITY ASSURANCE AND QUALITY CONTROL

If intended for regulatory purposes, BMI samples must be analyzed by an accredited laboratory with documented QA/QC and analytical procedures approved by DWQ.

Frequency and type of quality control samples such as field replicates, laboratory duplicates, and measures of laboratory inter-analyst variability will be prescribed in project-specific Sampling and Analysis Plans (SAPs).

Experienced DWQ personnel (or other DWQ-authorized personnel) will conduct field audits for non-DWQ cooperators collecting BMI data for DWQ programmatic efforts or for compliance purposes at a frequency prescribed in the project-specific SAP.

REFERENCES

Peck, D.V., J.M. Lazorchak, and D.J. Klemm (editors). Unpublished draft. Environmental Monitoring and Assessment Program -Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams. EPA/XXX/X-XX/XXXX. U.S. Environmental Protection Agency, Washington, D.C.

Related DWQ Documents:

Standard Operating Procedure for Decontamination of Monitoring Equipment

Utah Division of Water Quality: Quality Assurance Program Plan for Environmental Data Operations

Utah Comprehensive Assessment of Stream Ecosystems (UCASE) Field Operations Manual

UCASE WATER CHEMISTRY AND MACROINVERTEBRATE SAMPLE COLLECTION FORM-WADEABLE STREAMS

Reviewed by (initial):______

SITE/STORET ID:__ __ __ __ __ __ __ __	DATE:__ __/__ __/ 2 0 __ __

WATER CHEMISTRY

Sample Bottle	Sample Collected?	Sample Bottle	Sample Collected?	Process: See protocol	Comments/Flags
Total Chemistry	Y / N	Filtered Metals	Y / N	**Preservation:** Place water chem on ice and chlorophyll-*a* on dry ice	
Non-Filtered Nutrient	Y / N	Chlorophyll-*a* (water column)	Y / N	**Lab:** State of Utah Health Lab within one week of collection.	
Filtered Nutrient	Y / N		Volume filtered: ____________mL	**Shop storage:** Fridge and freezer	

TARGETED BENTHOS SAMPLE

No. of Jars (Primary)	Was a Replicate Sample Taken (if Yes, record no. of jars?	Collection Method (Choose one)	Comments/Flags
___ ___	Y / N ___ ___	○D-net ○Modified surber ○Other (indicate in comments)	

TRANSECT:		_____		_____		_____		_____	
Dom. Substrate	Channel	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.
Fine/Sand	Pool	○F	○P	○F	○P	○F	○P	○F	○P
Gravel	Glide	○G	○GL	○G	○GL	○G	○GL	○G	○GL
Coarse	Riffle	○C	○RI	○C	○RI	○C	○RI	○C	○RI
Other: Note in Comments	Rapid	○O	○RA	○O	○RA	○O	○RA	○O	○RA

SUBSTRATE SIZE CLASSES	_____		_____		_____		_____	
F/S – ladybug or smaller (<2 mm)	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.
G – ladybug to tennis ball (2 to 64 mm)	○F	○P	○F	○P	○F	○P	○F	○P
C – tennis ball to car sized (64 to 4000 mm)	○G	○GL	○G	○GL	○G	○GL	○G	○GL
O – bedrock, hardpan, wood, vegetation, leaf litter, undercut, macrophyhtes, etc.	○C	○RI	○C	○RI	○C	○RI	○C	○RI
	○O	○RA	○O	○RA	○O	○RA	○O	○RA

Note:
- Always perform 8 kicks at every site.
- Target riffle habitat primarily. If riffles are scarce or absent (e.g. low gradient, beaver ponds, etc.), target edge habitats (e.g. overhanging veg., undercut banks, etc.) and mark "O" in the substrate column and explain situation in comments.
- If riffles are present, but scarce, multiple kicks can be performed at the same riffles throughout the reach.
- If kicks are made in beaver influenced areas, please explain in the comments section.

Process: Fill a clean wide-mouth bottle with ~40% of composite sample (use multiple bottles if necessary).
Preservation: Fill rest of bottle with denatured alcohol (EtOH) and seal lid with electrical tape. Keep secure in upright position.
Lab: Utah State University Bug Lab; submit in large batch at end of field season.
Shop storage: Store on shelf with other bug samples.

BENTHOS COMMENTS:	

Updated: 01/2013

Attachment 5.6. UDWQ Protocols for Pressure Transducer Data Loggers

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedure (SOP) for the installation and maintenance of pressure transducers in Utah's natural (rivers, streams, lakes) or engineered (ditches, canals, reservoirs) surface water bodies. This SOP applies to any DWQ monitor or non-DWQ cooperator installing or maintaining pressure transducers. This SOP also outlines the responsibilities of DWQ monitors to perform inspections of pressure transducers and associated equipment while collecting water samples or performing flow measurements at a site where a pressure transducer has been installed.

Level TROLL 300 pressure transducers are a low-cost and robust method of determining near-continuous flow in streams that are not gaged by another agency (such as the U.S. Geological Survey or a utility). The pressure transducer consists of an "absolute" or "uncompensated" pressure sensor which measures absolute pressure and is not vented to allow for compensation for atmospheric pressure. Therefore, atmospheric pressure is subtracted from the absolute measurement to determine the pressure from water. The pressure transducer will log the depth of water at set time intervals. Recorded values are stored in the sensor itself and are periodically retrieved by field personnel. By combining these logs of depths with a number of discharge measurements taken at the site, a rating curve can be developed, correlating the depth of water with the measured discharge. Once this correlation has been established, discharge may be inferred from water depth alone.

Flow data is used by DWQ scientists and engineers for a variety of purposes including but not limited to:

- understanding the effect of hydrologic condition on aquatic life uses
- determining pollutant loading and inputs into receiving waterbodies
- setting permit requirements for discharge of treated wastewater
- understanding groundwater/surface water interactions
- characterizing current water quality conditions and detecting long-term changes

The information discussed in this SOP is not a substitute for equipment user manuals or other technical documentation. Consult the appropriate manual for a complete guide to the proper use, calibration, maintenance, deployment, and troubleshooting of pressure transducer equipment/software. This SOP is to be used as a reference but the complete user manual should always accompany the field personnel.

The transducers are programmed to log the depth of water every 15 minutes. The installation site will be scoped for feasible placement of the transducer inside of a PVC pipe with the bottom of the pipe as close as possible to the low-water level of the stream and the top of the pipe as high as feasible above the current water level and the expected high water level. The PVC pipe will act as a stilling well to even out the wave action of the flowing water, and to prevent damage to the transducer by natural causes or intentional damage. The pipe will be attached at the site using one of a number of methods to safeguard against high flows and vandalism.

Discharge: A term used in this SOP interchangeably with "flow". This is the volume of water flowing per unit of time. A flow or discharge measurement is a manual measurement of stream flow performed by a DWQ monitor/cooperator.

Gaging station: This is a site where flow is being measured continuously and automatically using devices such as, but not limited to, pressure transducers.

Pressure transducer: A device that measures pressure

PVC: Polyvinyl chloride

Reference level: The fixed elevation or height under the water at which the pressure transducer is installed

Stage: The height of the surface of the water in relation to the reference level

Stilling well: A cylinder installed near a body of water used to hold and protect hydrological sensors. The stilling well allows water to move in and out freely to interact with sensors but dampens wave and current action so as to provide a representative water level and to reduce noise in water level data.

In most cases, installation of pressure transducers will take place on stream banks. Most sites for installation of pressure transducers are near bridges fortified with rip-rap, which can be unstable, slippery, and sharp. Stream banks, where transducers are often installed are steep, slippery, and covered in cobble. Power tools, including hammer drills and sawzalls, can be hazardous if used improperly. Working near water in waders poses a drowning hazard, and working near water in the winter poses a hypothermia hazard.

Since the pressure transducer relates recorded depth of the transducer to recorded flow at the site, it is imperative that the transducer remain at the reference level, or height under water, for the duration of measurements. The transducer will need to be removed from the PVC pipe to download data and to clean out any debris or sediment, and care should be exercised to return the transducer to the same level from which it was retrieved.

Flow measurements (see DWQ's SOP for Stream Flow Measurements) should be conducted by monitoring staff as accurately as possible as a limited number of flow measurements will be used to interpolate a range of discharge from the depths recorded by the transducer.

The PVC pipe must be anchored firmly enough to prevent movement, which would change the reference depth of the transducer.

A senior Utah DWQ monitoring staff member will be the primary responsible party for installation of pressure transducers and development/maintenance of rating curves. This monitor will also be responsible for training new field staff.

Personnel installing pressure transducers and taking flow measurements should be knowledgeable of the relation between stream depth, or stage, and stream flow. Programming the transducers requires knowledge of computers and deployment software. Installation of the stilling wells and transducers is physically demanding and requires the use of a T-post driver, 3 pound hammer, hammer drill, and cable cutters.

Monitors that may be performing inspections of installed pressure transducers are required to read this SOP annually and acknowledge they have done so via a signature page (see Error! Reference source not found.) that will be kept on-file at DWQ along with the official hard copy of this SOP. Before new personnel can install pressure transducers or perform gage maintenance they must be trained by an experienced DWQ monitor. The signature page will be signed by both trainee and trainer to confirm that training was successfully completed and that the new monitor is competent in carrying out this SOP.

- ☐ Copy of this SOP
- ☐ Field Form (**Appendix 1**)
- ☐ In-Situ Inc. Level TROLL 300 logging pressure transducer or equivalent.
- ☐ Win-Situ 5 logger software

- In-Situ Inc. RS232 TROLL Com Direct Connect communication cable
- Laptop or desktop computer to communicate with the Level TROLL 300
- 1.5-inch diameter PVC Schedule 40 electrical conduit pipe, 10-foot length cut to fit specific installation
    - ¼- inch holes drilled from end to 12 inches up pipe, every 90 degrees around and every 2 inches to allow water to equilibrate in pipe
    - 3/8-inch hole drilled two inches from top of pipe, to allow water to equilibrate in pipe and for the attachment of padlock
- Two 1.5-inch PVC caps
    - Bottom cap drilled with ¼-inch holes in bottom for water to equilibrate and sediment to drop out; attached to pipe with self-tapping screws to allow removal for cleaning
    - Top cap friction fitted onto top of pipe, no modifications
- Lengths of 3/32-inch vinyl coated braided stainless-steel (SS) cable to attach pressure transducer inside PVC pipe to padlock; cut to fit specific installation
- 3/32-inch cable ferrules to attach SS cable to pressure transducer and form loop in top of cable to attach to padlock
- Attachment materials and tools
    - ¾-inch SS strapping, seals, and tensioner
    - Hammer drill, 3/32-inch masonry bits, ¼-inch X 2-inch masonry screws
    - Powder-actuated nailer, powder charges, and concrete pins
    - 1.5-inch two-hole metal conduit straps
    - 5-foot T-posts, post driver, 3 pound single jack sledgehammer, 2-foot rebar
- Keyed or combination long-shackle padlock to secure the transducer on the SS cable in the PVC pipe (Utah DWQ uses combination locks; combination code can be found in the site portfolio)
- In-Situ Inc. BaroTROLL, one unit per general geographic area to provide a log of the atmospheric pressure

Calibration

4) The In-Situ Level TROLL 300s are calibrated at the factory and no calibration or standardization is necessary before use.

5) The life of a transducer and how long it will maintain its calibration is dependent upon the duration of use, exposure to extreme environmental conditions, and how carefully it is handled during storage, transportation, and use. If needed, calibration is possible with the Level TROLL and the procedure is detailed in the Level TROLL Operators Manual.

6) Record the serial number and factory calibration date for the pressure transducer on the field form (**Appendix 1**) maintained in the site portfolio folder.

Installation

10) Determine where detailed flow measurements are required and assess the best location to install the stilling well and transducer. The stilling well should be mounted to a permanent object (*e.g.*, bridge piling) at a location where the channel cross section is not likely to change over time. In addition, this location should be suitable for obtaining discharge measurements by wading or deploying a Q-boat from a bridge or cable.

11) Using Win-Situ 5 or equivalent software, program the transducers to log depth readings every 15 minutes, using the procedure outlined in the software. The Level TROLLs can be programmed to log immediately, or a delayed start may be used. In either case, ensure in the software that the unit is programmed and is logging or will begin logging at the programmed time and date. Include in the programming the name of the site and date of deployment.

12) Based upon the site, determine the length of the PVC pipe that is feasible to reach down to low water and ideally above high water. The transducers are water-tight, so no damage will occur if the top of the pipe is not above water throughout the year.

13) Using this determined length, cut the PVC pipe from the top, if necessary, to the appropriate length. The 3/8-inch hole for the padlock will need to be re-drilled 2 inches below the top of this new length of pipe.

14) Using the 3/32-inch SS cable and ferrules, make a tether for the pressure transducer inside the PVC pipe.

    a) Place a ferrule on the cable, run the end through the eyelet on the top of the transducer then through the ferrule again, forming approximately a 2-inch loop. Clamp in place using a ferrule clamp or the 3-pound sledge and a hard surface.

    b) Holding the other end of the cable, lower the transducer on the cable into the pipe until it reaches the bottom cap. Pull the transducer up approximately ½-inch above the cap and mark the cable at the location of the top hole in the pipe for the padlock. Form a loop with this mark at the top, and cut the cable with adequate length to make this loop. Check that the transducer will be approximately ½" above the bottom cap when the padlock is run through the pipe and top loop of the tether, and clamp the top loop using one of the above methods.

    c) This will create a tether of set length with the transducer at the bottom end and an approximately 2-inch loop at the top end.

15) The transducer on the end of the tether can be inserted into the stilling well, and secured by inserting the free end of the padlock shackle through one of the 3/8-inch holes at the top of the well, hooking

the tether loop over the shackle inside the pipe, then inserting the shackle through the other hole (other side of pipe) and locking the padlock.

16) Place the top cap on the stilling well.

17) To attach the stilling well at the determined site, one of several methods can be employed, listed in order of preference:

   a) If using a bridge pylon or other vertical structure that extends into the stream as low as the low water mark, the stilling well can be strapped to the downstream side (to minimize wakes caused by the structure) using the SS strapping, seals and SS tensioner. Detailed instructions on using these tools can be found at: http://www.uline.com/PDF/IH-1273.PDF.

   b) If using a vertical surface, such as a bridge abutment at the downstream side where the SS strapping cannot be wrapped around the surface, the 1.5-inch metal conduit straps can be used to attach the stilling well. If the vertical surface is concrete, as is likely, a hammer drill and concrete screws or powder-actuated nailer and concrete nails will be used to attach the stilling well, nailing or screwing down the straps over the stilling well in at least two spots, typically just above current water level and near the top of the well.

   c) If no vertical surface is present, the transducer can be attached to a diagonal surface, such as a stream bank. The transducer records absolute depth of water, so the stilling well in a diagonal position will not affect readings. Determine best location of stilling well, and mark two or more locations to drive T-posts or sections of rebar into the stream bank to use as attachment points for the stilling well. Position the posts downstream of the stilling well location and drive them as deep as possible to provide a good anchor and prevent a hazard. Attach the stilling well using the SS strapping around the well and post to prevent movement and vandalism.

18) Record the date of deployment on the field form (**Appendix 1**).

Inspection and Maintenance

4) The transducers should be inspected whenever feasible to ensure no damage, shifting, or vandalism has occurred. All DWQ monitors are provided with a list of the sites that are gaging stations. Monitors perform a visual inspection of the gage each time they visit that site. In addition, the monitor responsible for maintaining DWQ's gaging stations may visit the site to perform inspections and maintenance at more frequent intervals.

5) The monitor responsible for maintaining DWQ's gaging stations will determine the frequency at which more detailed inspections of the pressure transducer and inside of the stilling well will be performed. The transducer can be removed from the well to remove debris or sediment and the pressure transducer and stilling well can be cleaned. At a minimum, a detailed inspection and maintenance should be performed during data retrieval.

6) Record that an inspection and/or maintenance was performed on the field form (**Appendix 1**).

Data Retrieval

5) To retrieve the pressure transducer, remove the PVC cap and unlock the padlock. Pull on the SS cable to lift the pressure transducer out of the pipe.

6) To download the data, remove the protective cap from the transducer and plug it into the laptop using the RS232 Direct Connect cable. Win-Situ 5 will recognize the instrument, and prompt the user to connect and download the data.

7) Make certain the transducer is once again logging at the 15 minute intervals, and reinsert into the stilling well, attaching the tether with the padlock. The 2-inch loop ensures that the pressure transducer is lowered to the same depth from which it was retrieved.

8) Record that data retrieval was performed on the field form (**Appendix 1**).

- The field form in **Appendix 1** should be included in the site portfolio of every site where a pressure transducer has been installed. Use this form to record installation of the pressure transducer, inspections and maintenance performed, data retrievals performed, and to note when a flow measurement has been performed manually by a monitor. In addition, monitors/cooperators should notify the senior monitor responsible for the gaging station when a flow measurement has been performed at that site.

- Upon returning to the office with downloaded transducer data, the file should be uploaded to the Monitors folder on the Utah DWQ server to safeguard it against loss.

- The Win-Situ 5 software will store the logged depths and the logged barometric pressures. In-Situ Inc.'s Baro Merge Software will compensate the logged depths for changes in barometric pressure, improving accuracy.

- The BaroTROLL is identical to the Level TROLL except it is deployed in air. The BaroTROLLs are set up the same way, recording barometric pressure every 15 minutes. They need to be downloaded the same way as well, at the same time as the Level TROLLs.

- Using flow determinations and the logged depth at the time of flow measurement, a stage-discharge rating curve will be created. From the curve, an equation can be made that will allow all of the logged depths to be converted into flow estimations. Flow measurements are performed each time monitors collect water samples, if conditions allow. The monitor responsible for maintaining DWQ's gaging stations will determine the frequency at which flow measurements performed specifically for rating curve assessments/adjustments need to be performed. A minimum of five flow determinations should be made for a reasonable stage-discharge rating curve.

Follow all procedures described in this SOP to ensure valid, high quality pressure transducer measurements. Follow all procedures described in DWQ's SOP for Stream Flow Measurement to ensure valid, high quality flow measurements that can be used to develop rating curves for gaged sites.

Keep up-to-date equipment maintenance records and calibration data (**Appendix 1**) with other site records to provide defense of quality data from installed pressure transducers.

THE IN-SITU INC. WEBSITE (HTTP://WWW.IN-SITU.COM/) HAS WIN-SITU SOFTWARE UPDATES AND HELPFUL QUICK GUIDES, INSTRUMENT MANUALS, INSTRUCTION SHEETS AND TECHNICAL NOTES INCLUDING:

- Level TROLL 300, 500, 700, and BaroTROLL Operator's Manual (http://www.in-situ.com/Manuals)
- Win-Situ 5.0 User's Guide (http://www.in-situ.com/Win_Situ5)
- Level TROLL 300, 500, and 700 Quick Start Guide (http://www.in-situ.com/QuickStarts)
- Technical Note: Using Baro Merge Software (http://www.in-situ.com/Baro_MergeSoftware)

Goering, T. (2008). Pressure transducer installation, removal, and maintenance. Los Alamos National Laboratory Standard Operating Procedure SOP-5227, Revision 0, Effective Date 10/28/2009. http://www.lanl.gov/environment/all/ docs/qa/ep_qa/SOP-5227.pdf.

Yerington Mine Site. (2009). Pressure transducer water level monitoring standard operating procedure SOP-21, Revision 1, Revision Data 4/28/2009. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/cf0bac722e32d408882574260073faed/120f26eb0d420d8b882575e1006899ae/$FILE/SOP-21r1%20Pressure%20Transducer%20Water%20Level%20Monitoring.pdf.

Appendix 2 – Pressure transducer field form

(U:\WQ\PERMITS\MONITORS\Pressure Transducers\Pressure Transducer Field Form.pdf)

Utah DWQ, May 2011

Utah DWQ Pressure Transducers
Installation, Inspection and Maintenance Form

Site Name:_______________________________ STORET:_______________________________
Latitude:_______________________________ Longitude:_______________________________
Site Description:_______________________________
Pressure Transducer Make/Model/Serial Number:_______________________________
Pressure Transducer Factory Calibration Date:_______________ Installation/Deployment Date:_______________
Installation Personnel:_______________________________
Notes from Installation:_______________________________

Date	Monitor Initials	Visual Inspection Performed (Y or N)	Visual Inspection Okay (Y or N)	Data Retrieval Performed (Y or N)	Battery Life Remaining	Memory Remaining	Maintenance Performed (Y or N)	Flow Measurement Performed (Y or N)	Equipment Condition, Comments, Describe Maintenance

U:\WQ\PERMITS\MONITORS\Pressure Transducers\Pressure Transducer Field Form.doc Page _____ of _____

UCASE WATER CHEMISTRY AND MACROINVERTEBRATE SAMPLE COLLECTION FORM-WADEABLE STREAMS

Reviewed by (initial): ______

SITE/STORET ID:__ __ __ __ __ __ __ __ DATE:__ __/__ __/ 2 0 __ __

WATER CHEMISTRY

Sample Bottle	Sample Collected?	Sample Bottle	Sample Collected?	Process/Preservation	Comments/Flags
Total Chemistry	Y / N	Filtered Metals	Y / N	**Process:** See protocol **Preservation:** Place water chem on ice and chlorophyll-*a* on dry ice **Lab:** State of Utah Health Lab within one week of collection. **Shop storage:** Fridge and freezer	
Non-Filtered Nutrient	Y / N	Chlorophyll-*a* (water column)	Y / N		
Filtered Nutrient	Y / N		Volume filtered: ____________mL		

TARGETED BENTHOS SAMPLE

No. of Jars (Primary)	Was a Replicate Sample Taken (if Yes, record no. of jars?	Collection Method (Choose one)	Comments/Flags
___ ___	Y / N ___ ___	○D-net ○Modified surber ○Other (indicate in comments)	

TRANSECT:		____		____		____		____	
Dom. Substrate	Channel	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.
Fine/Sand	Pool	○F	○P	○F	○P	○F	○P	○F	○P
Gravel	Glide	○G	○GL	○G	○GL	○G	○GL	○G	○GL
Coarse	Riffle	○C	○RI	○C	○RI	○C	○RI	○C	○RI
Other: Note in Comments	Rapid	○O	○RA	○O	○RA	○O	○RA	○O	○RA

SUBSTRATE SIZE CLASSES	____		____		____		____	
F/S – ladybug or smaller (<2 mm)	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.	Sub.	Chan.
G – ladybug to tennis ball (2 to 64 mm)	○F	○P	○F	○P	○F	○P	○F	○P
C – tennis ball to car sized (64 to 4000 mm)	○G	○GL	○G	○GL	○G	○GL	○G	○GL
O – bedrock, hardpan, wood, vegetation, leaf litter, undercut, macrophyhtes, etc.	○C	○RI	○C	○RI	○C	○RI	○C	○RI
	○O	○RA	○O	○RA	○O	○RA	○O	○RA

Note:

- Always perform 8 kicks at every site.

- Target riffle habitat primarily. If riffles are scarce or absent (e.g. low gradient, beaver ponds, etc.), target edge habitats (e.g. overhanging veg., undercut banks, etc.) and mark "O" in the substrate column and explain situation in comments.

- If riffles are present, but scarce, multiple kicks can be performed at the same riffles throughout the reach.

- If kicks are made in beaver influenced areas, please explain in the comments section.

Process: Fill a clean wide-mouth bottle with ~40% of composite sample (use multiple bottles if necessary).
Preservation: Fill rest of bottle with denatured alcohol (EtOH) and seal lid with electrical tape. Keep secure in upright position.
Lab: Utah State University Bug Lab; submit in large batch at end of field season.
Shop storage: Store on shelf with other bug samples.

BENTHOS COMMENTS:	

Updated: 01/2013

RESEARCH VIGNETTE

NAME: Wally Macfarlane, Jordan Gilbert, Joe Wheaton, Martha Jensen, Shane Hill, Chris Smith, and Josh Gilbert
DATE: Aug 20, 2015
STUDY SITE(S): Colorado Plateau Ecoregion, State of Utah, Columbia River Basin
PROJECT: CPE Floodway Delineation, Utah Statewide Riparian, and CHaMP

QUESTION / PROBLEM

Riparian zones in the Western US are particularly important elements of landscape heterogeneity, where they are often the dominant wetland elements in otherwise dry landscapes (Knopf et al. 1988), and support a disproportionately high level of bird and mammalian species diversity and abundance relative to the rest of the landscape (Johnson et al. 1977; Knopf 1985; Soderquist and MacNally 2000). In addition, interactions between intact native riparian vegetation, hydrologic disturbance regimes and channel substrates forms complex fish habitat (Kauffman et al. 1997). Nevertheless, numerous riparian zones throughout the Western U.S. are threatened or impaired by altered flow patterns, water withdrawals, and establishment of non-native plant species (Goodwin et al. 1997; Stromberg et al. 2007; Poff et al. 2011). This degradation is often expressed by a simplification in stream structure (e.g., loss of pools, decreased channel sinuosity, and loss of channel complexity) (Kauffman et al. 1997).

Given both the importance of riparian ecosystems and enormous spatial extent of riparian degradation, watershed-level assessments are critical, yet often not undertaken due to lack of appropriate assessment methodologies. As such, there is a desperate need to develop new methods to identify both areas in natural functioning condition that can be dedicated as conservation zones and areas with the potential for improvement as priority restoration zones (Wissmar and Beschta 1998; Poiani et al. 2000).

IDEA / HYPOTHESIS

The development of a systematic riparian vegetation condition assessment method is critical for watershed-level conservation and restoration planning (e.g., Harris and Olson 1997; Mollot et al. 2007). We believe that such a watershed-level riparian vegetation condition assessment approach can be developed by leveraging LANDFIRE data, a nationally available land cover classifications that is based on 30 m spatial resolution Landsat satellite imagery, to effectively approximate riparian vegetation condition at the reach scale.

METHODS

Riparian Vegetation Condition Assessment (RVCA)

RVCA uses LANDFIRE Existing Vegetation Type (EVT) and Biophysical Settings (BpS) data to estimate riparian vegetation change since Euro-American settlement at a reach level (200 – 500 m segments). The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. We used the BpS layer to represent the reference (pre-settlement) vegetation condition and the EVT layer was used to represent the current (2012) vegetation condition. The vegetation condition assessment was accomplished by coding native riparian vegetation as a 1 and non-native riparian and upland classes as a 0. In addition, within large rivers, the open water class was coded as NoData and outside of large rivers open water was coded as a 1. This coding was determined through test runs of the assessment that found that if all open water was classified as a 1 it skewed large river conditions to appear to be in better shape than they really are and if all open water was classified as NoData it skewed the smaller river riparian areas to appear to be in worse shape than they really are. The following equation was used to calculate a dimensionless ratio:

(mean EVT vegetation value)/(mean BpS vegetation value)

The lower the value (closer to 0) the more degraded the riparian vegetation condition was compared to the pre-settlement condition. Values larger than 1 showed areas that have increased in native riparian vegetation since settlement.

Riparian Conversion Assessment (RCA)

RCA is a supplement to the RVCA method and provides information to explain what might be causing degradation along the stream network. Like RVCA, RCA uses LANDFIRE EVT and BpS data. The BpS riparian vegetation was coded as 1 and all other vegetation types were coded as a 0. The EVT vegetation types were given codes from 1 to 17 using only odd numbers. Overlaying the two layers provided a new layer with values 1 to 18, where even numbers represented conversions related to historic riparian vegetation cover. Each segment of valley bottom was categorized based on the conversion type with the majority of riparian conversion related pixels within the segment. The output of this process displays the most prevalent cause of riparian conversion within each given segment. This output in combination with the results of the RVCA provide a more complete and explicative product for use in assessing riparian area condition.

Both of these processes have been automated and converted into an ArcGIS tool and are described in this vignette.

PREPROCESSING

STREAM NETWORK

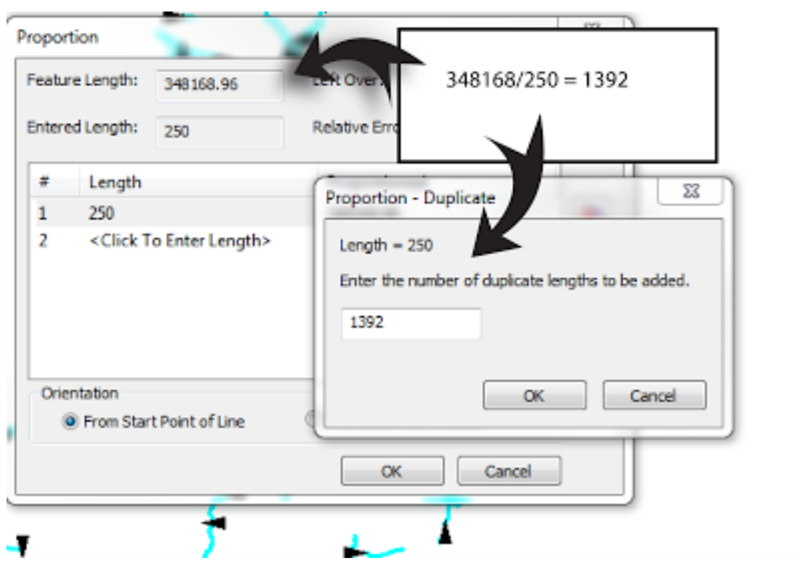
- Dissolve all segments of NHD perennial streams into one segment. Use the "Dissolve" tool. Do NOT use any Dissolve Field(s) and select (check) "Create multi-part features (optional)"
- Go to Customize - Toolbars - check COGO
- Start **Editing** the dissolved NHD line
- Right Click on the line. Go to Selection - Select All

- Click on the COGO proportion tool in the COGO toolbar

The COGO Proportion tool

- Enter your desired stream length in the length 1 box (i.e. 500 meters)
- Click on the DUPLICATE box on the right hand side of the Proportion tool

- Enter the amount of duplicates of stream length desired. You can obtain this number by dividing the Feature Length (in the proportion tool) by your desired stream length. Enter the number in the duplicate box and hit OK



- Choose FROM END POINT OF LINE, then OK. It may take a few minutes to segment your line
- Convert the multipart drainage network to a singlepart drainage network. Use the tool "Multipart to Singlepart"

VALLEY BOTTOM

A valley bottom polygon is also a required input to run the RVCA tool. Instructions on producing a valley bottom polygon can be found at https://sites.google.com/a/joewheaton.org/et-al/nhd-network-builder-and-vbet. The only required inputs are a digital elevation model (DEM) and stream network.

LARGE RIVER POLYGONS (OPTIONAL)

In areas with large rivers (i.e., Colorado Green, Snake, Columbia, etc.), the tool should be run with a large river polygon as an optional input. When downloading NHD data for a watershed of interest, a shapefile called “NHDArea” is included in the data. This is a polygon that generally delineates the medium to large rivers and can be easily clipped down to whatever rivers are being considered “large” for the analysis and used as the large river polygon.

ADDITIONAL DATA

LANDFIRE EVT and BPS layers should also be downloaded for the area of interest. See http://landfire.gov/ to download the data.

HOW THE RVCA TOOL WORKS

THIESSEN POLYGONS

The segmented network input is used to create point features, a midpoint for each individual segment. These points are then used to generate Thiessen polygons. The valley bottom input is buffered by 30 meters (to ensure that the 30 meter raster calls can be completely contained by the valley bottom in headwater reaches). The buffered valley bottom is then used to clip the Thiessen polygon layer. These Thiessen polygons become the area within which the RVCA Tool calculations will be summarized and applied to the stream network (Figure 1).

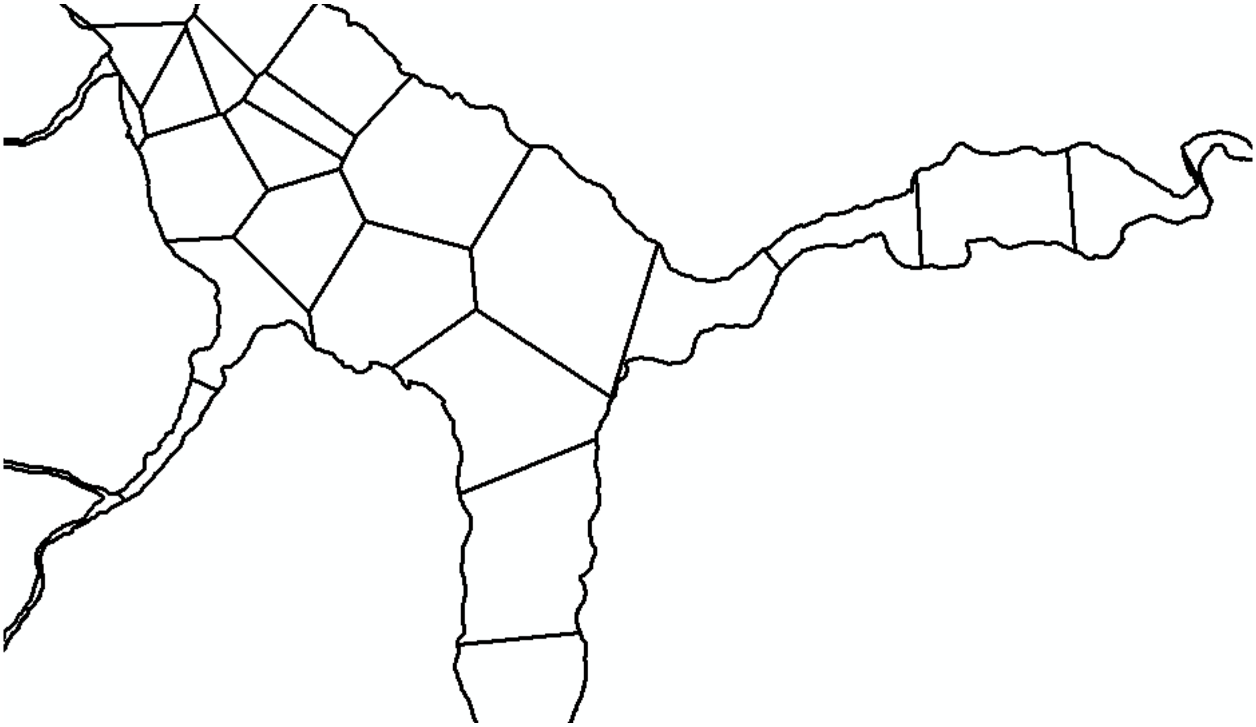


Figure 1 - Example Thiessen polygons clipped to a valley bottom.

LANDFIRE LANDCOVER CLASSIFICATION

After creating the Thiessen polygons, the tool classifies the LANDFIRE rasters. It does this by creating a “VEG_SCORE” field and coding LANDFIRE existing (2012) (US 130 EVT) vegetation and potential (pre-settlement) (US 130 BPS) vegetation based on native riparian (1), and all others (including introduced riparian vegetation) (0) (Figure 2).

Table 1 - Example vegetation score table

US120EVT_ER3.img

SYSTMGRPPH	SYSTMGRPNA	SAF_SRM	Veg_Score
Hardwood	Aspen Forest, Woodland, and Parkland	SAF 217: Aspen	1
Riparian	Western Riparian Woodland and Shrubland	SAF 235: Cottonwood-Willow	1
Riparian	Western Riparian Woodland and Shrubland	SRM 203: Riparian Woodland	1
Riparian	Western Riparian Woodland and Shrubland	SAF 235: Cottonwood-Willow	1
Riparian	Western Riparian Woodland and Shrubland	SRM 422: Riparian	1
Riparian	Western Riparian Woodland and Shrubland	LF 42: Great Plains Riparian	1
Riparian	Western Herbaceous Wetland	SRM 422: Riparian	1
Riparian	Western Riparian Woodland and Shrubland	SAF 235: Cottonwood-Willow	1
Riparian	Western Riparian Woodland and Shrubland	SRM 422: Riparian	1
Riparian	Western Riparian Woodland and Shrubland	LF 42: Great Plains Riparian	1
Riparian	Western Riparian Woodland and Shrubland	LF 42: Great Plains Riparian	1
Riparian	Western Riparian Woodland and Shrubland	SAF 235: Cottonwood-Willow	1
Riparian	Western Riparian Woodland and Shrubland	SRM 203: Riparian Woodland	1
Open Water	Open Water	Non-vegetated	8
Riparian	Depressional Wetland	SRM 601: Bluestem Prairie	1
Sparsely Vegetated	Sparse Vegetation	LF 33: Sparsely Vegetated	0
Sparsely Vegetated	Sparse Vegetation	LF 33: Sparsely Vegetated	0
Sparsely Vegetated	Sparse Vegetation	LF 33: Sparsely Vegetated	0
Hardwood	Bigtooth Maple Woodland	SRM 418: Bigtooth Maple	0

LANDFIRE OPEN WATER CLASSIFICATION FIXER

Within large rivers the open water class is coded as NoData and outside of large rivers open water is coded as a 1. This coding was determined through test runs of the RVCA that found that if all open water was classified as a 1 it skewed large river conditions to appear be in better shape than they really are and if all open water was classified as a NoData it skewed the smaller river conditions to appear to be in worse shape than they really are. This splitting of the open water coding was accomplished by generating a major rivers (Green, Colorado, San Juan, and Yampa rivers) polygon and using this polygon as a clipping extent for the EVT and BPS LANDFIRE data. The Open water classifications within these river areas are re-classified as NoData (Figure 3).

The large river is clipped from the LANDFIRE rasters using the large river polygon. The "VEG_SCORE" field for the portion clipped to the rivers extent is reclassified to a value of 8. This raster of the large river is then added, using map algebra, to the original LANDFIRE rasters, resulting in raster values of 0, 1, 8 and 9, where 8 and 9 are the cells that are within the large river. This raster is then recoded so that 8 and 9 are NoData while 0 and 1 remain the same (Figure 4).

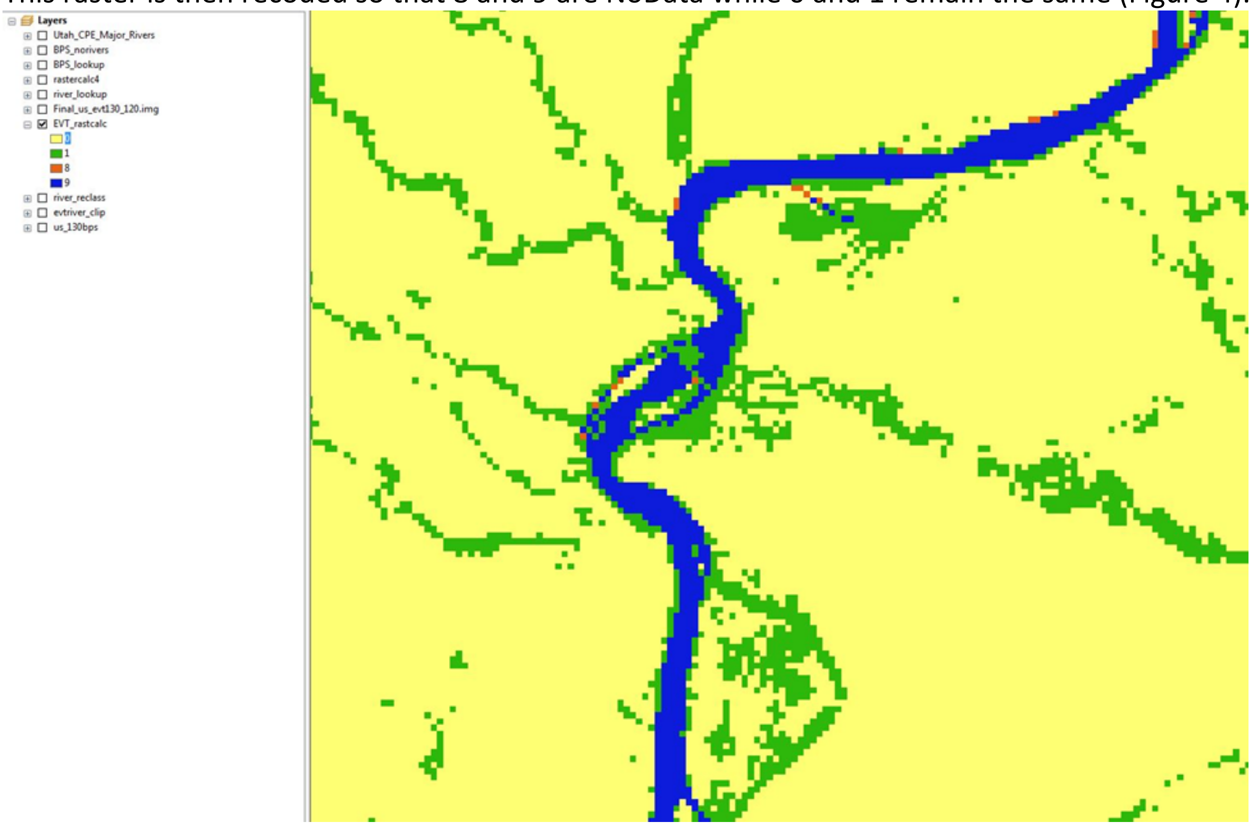


Figure 2 - LANDFIRE data showing open water.

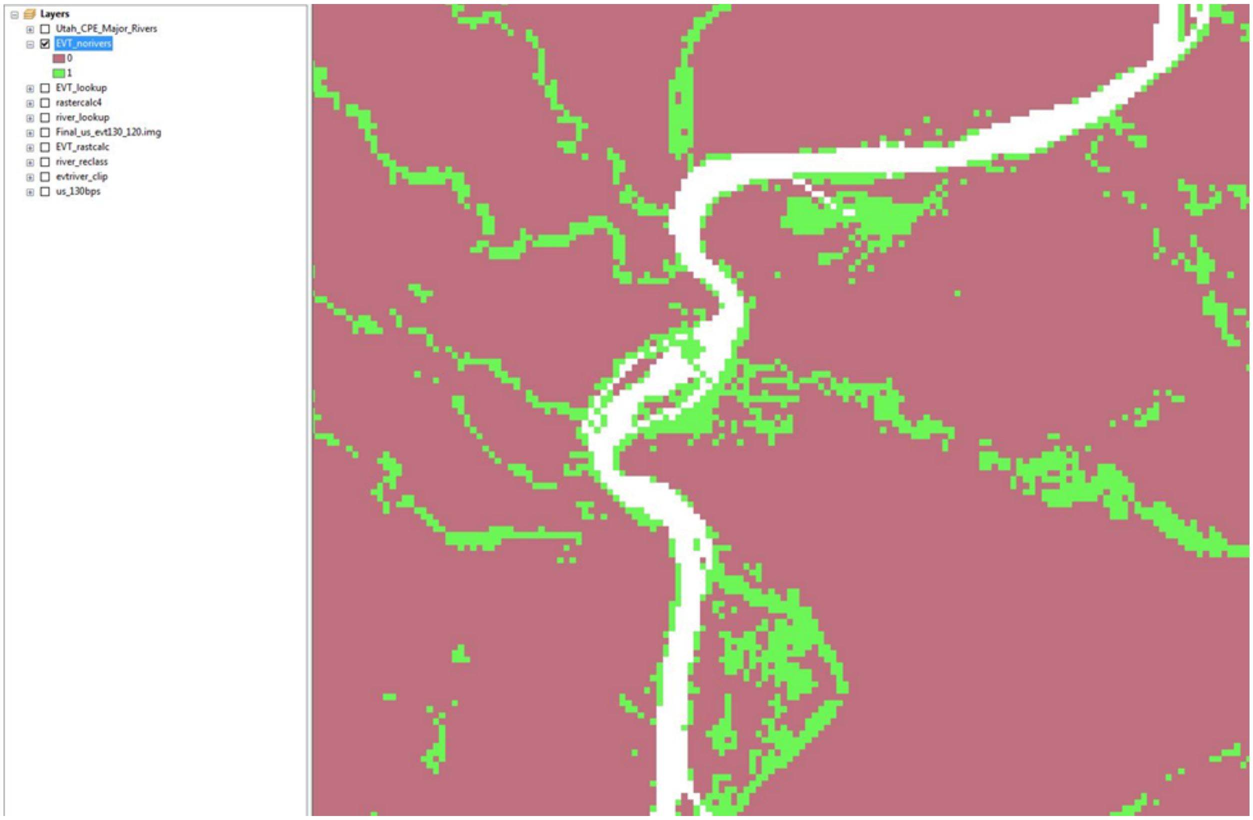


Figure 3 - LANDFIRE data open water recoded as nodata.

ZONAL STATISTICS

The RVCA tool then performs zonal statistics for both the reclassified EVT and BPS LANDFIRE layers. The Thiessen polygons are used as the boundaries, and the mean values are calculated for each raster within each of the Thiessen polygons. The result is two rasters:

1. the current mean riparian cover within each Thiessen polygon (mean EVT), and
2. the historic (potential) mean riparian cover within each Thiessen polygon (mean BPS).

TRANSFERRING RIPARIAN CLASSIFICATION TO THE STREAM NETWORK

These rasters must be converted to polygons in order to extract the values to the network, and in order to covert a raster to a polygon, it must be an integer raster. The zonal statistics rasters are each multiplied by 100 so that the values can be represented as integers, changed to integer rasters, and then converted to polygons. The segmented network is dissolved to be a single polyline, and then intersected with the polygons representing the mean existing and historic riparian cover values. This process segments the network at each Thiessen polygon boundary, and adds two new fields to the network: one it attains from the mean existing riparian cover polygons (mean EVT), and one which it attains from the mean historic riparian cover polygons (mean BPS). A new field called “COND_RATIO” is created and populated by dividing the mean EVT field by the mean BPS field. The result is a value between 0 and 1 representing the proportion of historic or potential riparian vegetation that is currently on the landscape. There are occasional values greater than one that represent a potential increase in riparian vegetation. Before these fields are divided, negative and zero values in the “BPS mean” field are changed to 0.0001 so that division by 0 or by a negative number does not occur.

RIPARIAN CONVERSION ASSESSMENT

LANDFIRE VEGETATION TYPE CODING

The EVT and BPS LANDFIRE rasters are again recoded based on vegetation type (Table 2 and 3).

Table 2 - BPS vegetation codes

BpS	Veg_Code
Riparian	1
All other Veg types	0

Table 3 - EVT vegetation codes.

EVT	Veg_Code
Riparian	1
Invasive Riparian	3
Invasive Upland	5
Conifers	7
Upland	9
Agriculture	11
Development	13
Sparsely Vegetated/Barren	15
Open Water	17

New rasters are generated from the “VEG_CODE” scores, and these two new rasters are added together using map algebra. By adding them together, the following table and figure illustrates how each new value is associated with a conversion type (Table 4 and Figure 4)

Table 4 - Conversion type table.

Conversion Type	Code
Non-Riparian to Riparian	1
Riparian (no change)	2
Non-Riparian to Introduced Riparian	3
Riparian to Introduced Riparian	4
Upland to Introduced Upland	5
Riparian to Introduced Upland	6
Conifer Woodland (no change)	7
Conifer Encroachment	8
Upland (no change)	9
Upland Encroachment	10
Upland Converted to Agriculture	11
Riparian Converted to Agriculture	12
Developed Upland	13
Developed Riparian Zone	14
Sparsely Vegetated (no change)	15
Riparian to Sparsely Vegetated	16
Open Water	17
Flooded	18

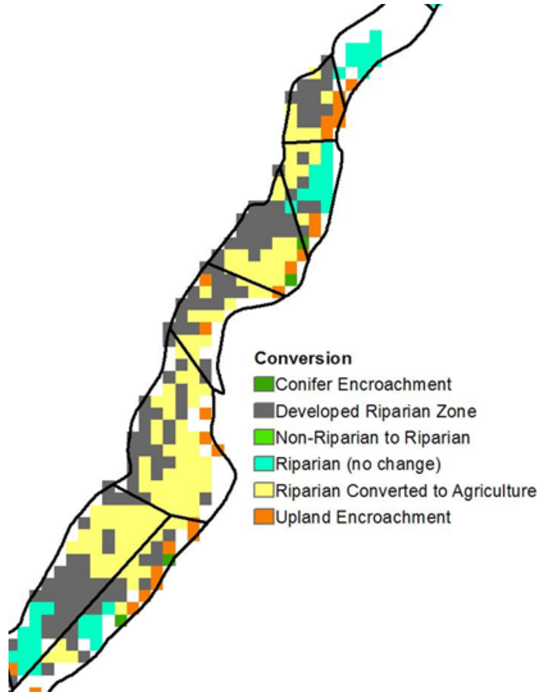


Figure 4- Conversion type by pixel value.

ZONAL STATISTICS

Zonal statistics are performed on this new conversion raster, but in this case the “MAJORITY” statistic is used to calculate which conversion type is most common within each of the Thiessen polygons.

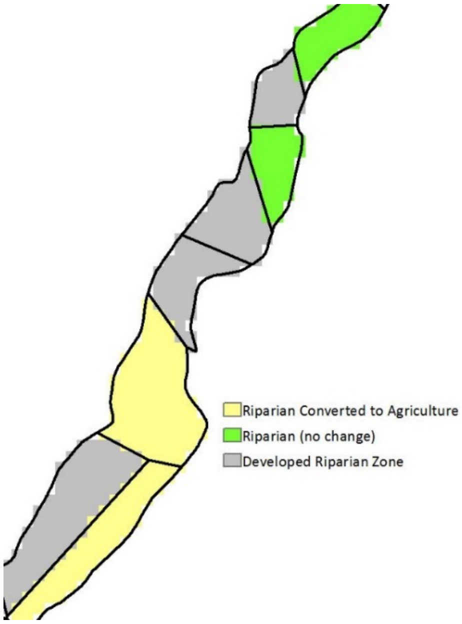


Figure 5 - Conversion type lumped by majority with each Thiessen polygon.

Using the same method as RCVA vegetation conversion information is extracted to the stream network, this conversion type raster is converted to a polygon and transferred to the stream network as a new attribute.

As stated before, this process has been automated using an ArcGIS tool (Figure 6). The inputs of the tool include:

1. a workspace,
2. a segmented stream network,
3. a valley bottom polygon,
4. the LANDFIRE EVT layer,
5. the LANDFIRE BPS layer, and
6. a large river polygon (optional).

The output is a stream network that includes attributes for both the riparian condition assessment values and the conversion type. The tool can currently be downloaded at https://bitbucket.org/jtgilbert/rvca.

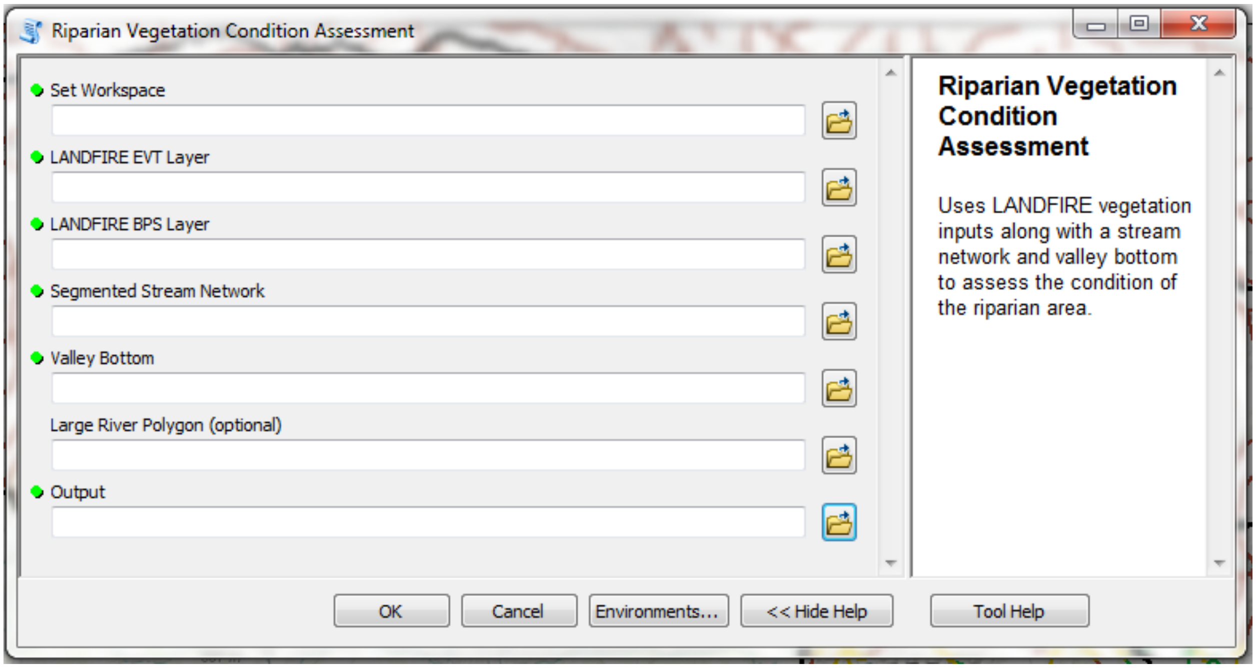


Figure 6 - Screen shot showing the Riparian Vegetation Condition Assessment Tool.

PRELIMINARY RESULTS

Figures 7 and 8 show preliminary outputs for the Weber River watershed in Northern Utah. The top figure shows the output for the riparian vegetation condition assessment, and the bottom figure shows the results of the conversion assessment.

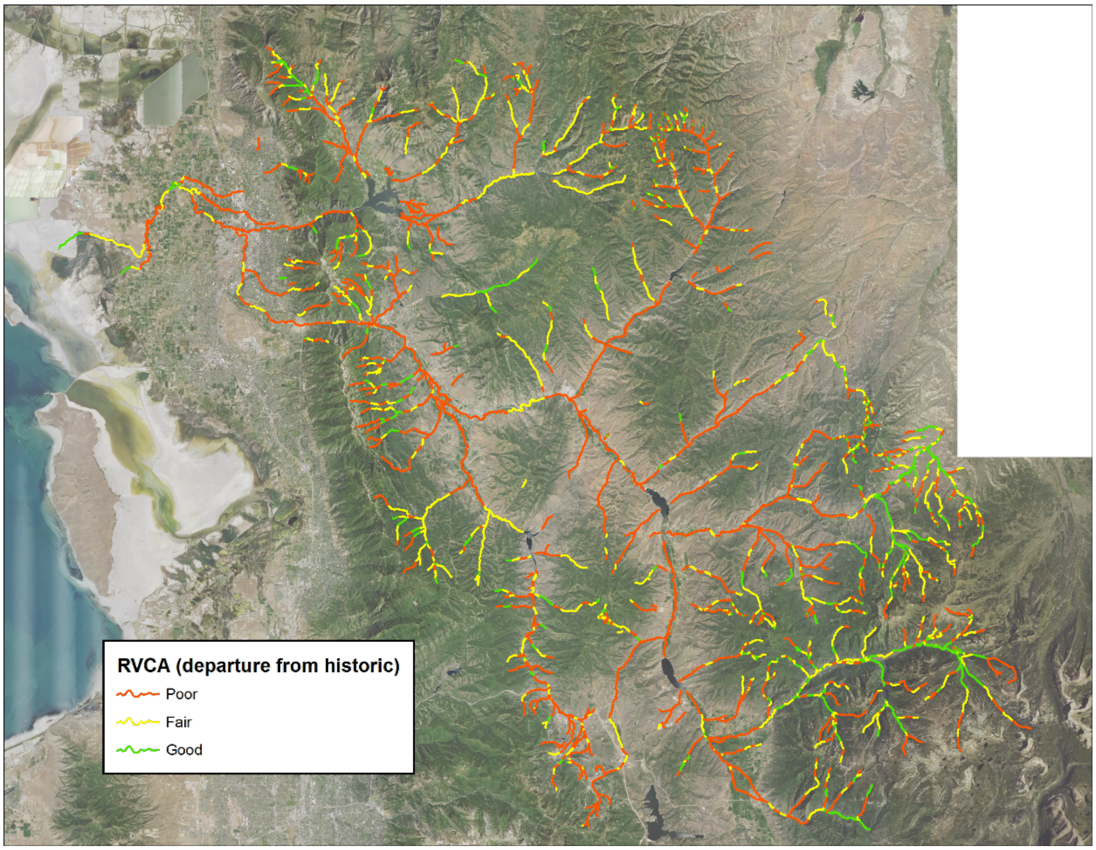


Figure 7 - Example Riparian Vegetation Condition Assessment tool output for the Weber River Watershed.

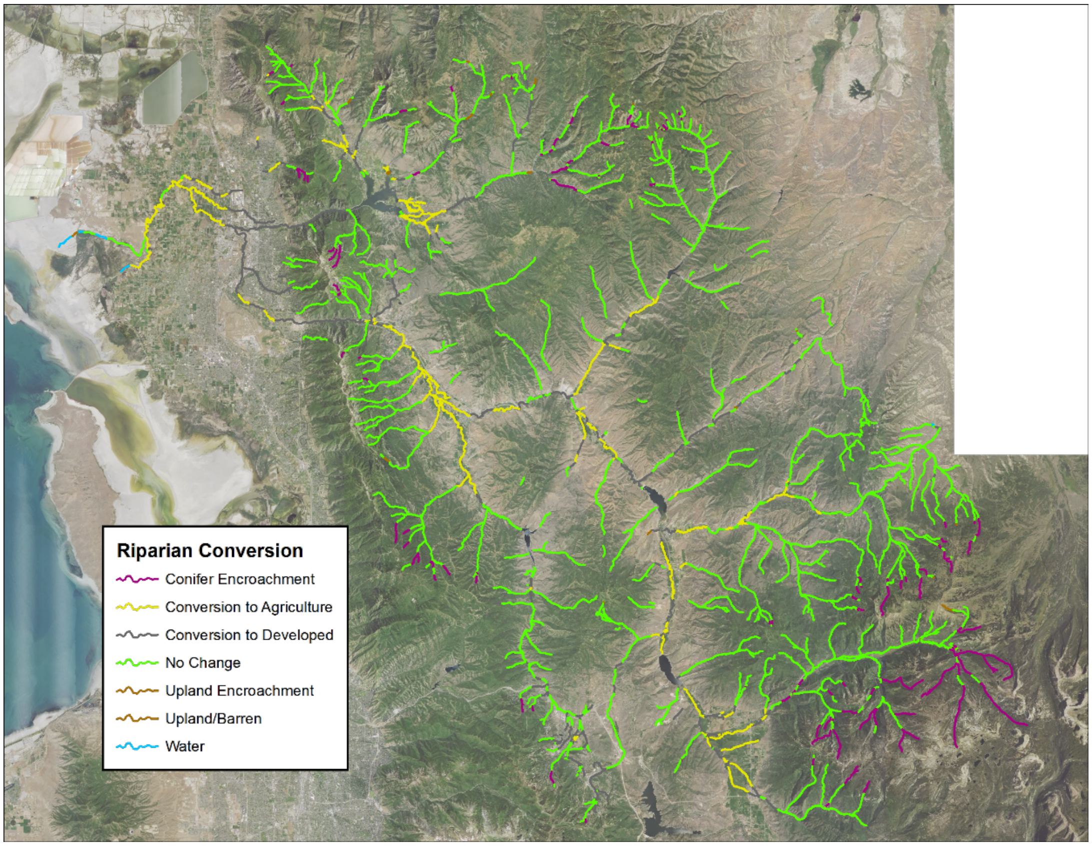


Figure 8 - Example output of the Riparian Conversion tool for the Weber River Waterhsed.

PRELIMINARY INTERPRETATIONS

We have run this method across the entire Colorado Plateau Ecoregion, the state of Utah and are in the early stages (Aug 2015) of testing the tool in the Columbia River Basin. Preliminary interpretations are that the method is appropriate for course evaluations of riparian vegetation conditions across large watersheds. However, in some instances LANDFIRE EVT data does not provide sufficient detail because the 30 m dataset lumps riparian vegetation into classes such as shrub cover, herbaceous cover, or cultivated crops and/or pasture.

FUTURE WORK & QUESTIONS

Further validation of LANDFIRE EVT data is needed. Re-coding of LANDFIRE EVT data in some riparian areas might be worth the effort. In the highest priority areas it might be worthwhile to collect new riparian vegetation data.

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LSSC Monitoring Plan, Appendix I Attachment 7: LSSC Streambank and Instream Condition Monitoring Data Sheet

Part 1: General Information & Bank Condition

Stream Name	**Monitoring Area ID or Description**	**Date**

Reference Marker – descriptive location, latitude & longitude (decimal degrees), & UTM coordinates (NAD 83)					
Location	Latitude	Longitude	UTM East	UTM North	Zone

Downstream Marker				**Upstream Marker**			
Latitude	Longitude	UTM East	UTM North	Latitude	Longitude	UTM East	UTM North

General Information on Stream at Monitoring Area						
Length (m)	Downstream elevation	Upstream elevation	Gradient (%)	Water temp (^{o}C)	pH	Salinity (mg/L)

Observers	**Sample Interval**

File Names of Monitoring Photos			
Lower Across	Lower Upstream	Upper Across	Upper Downstream

Streambank Condition (Incidence of mechanical trampling or shearing of the streambank)

Plot #	Incidence of mechanical trampling or shearing (Score 0 – 5 for each plot)	Plot #	Incidence of mechanical trampling or shearing (Score 0 – 5 for each plot)
1		21	
2		22	
3		23	
4		24	
5		25	
6		26	
7		27	
8		28	
9		29	
10		30	
11		31	
12		32	
13		33	
14		34	
15		35	

16		36	
17		37	
18		38	
19		39	
20		40	

Subtotal by Column			
Grand Total		Divided by 200 (% mechanical damage)	

Part 2: Greenline Composition[1] (Note: Multiple copies of this sheet are usually required)

Stream:					Monitoring Area:				Date:
		Non-Woody		Woody			Non-Woody		Woody
Plot No. (1 – 40)	GGW (nearest 0.1 m)	Species (E/N)	Percent (%) Cover	Species (E/N) Rooted in/overhanging	Plot No. (1 – 40)	GGW (nearest 0.1 m)	Species (E/N) Rooted in/overhanging	Percent (%) Cover	Species (E/N) Rooted in/overhanging
1					21				
2					22				
3					23				
4					24				
5					25				
6					26				
7					27				
8					28				
9					29				
10					30				
11					31				
12					32				
13					33				
14					34				
15					35				
16					36				
17					37				
18					38				
19					39				
20					40				

Page ___ of ___

[1] If the species is not initially recognized as native or exotic, note "?" and later confirm species identification and nativity.

Part 3: Streambed Substrate

Stream:											Date:
Monitoring Area:											Used Gravelometer (Y of N)?
Plot No.	Pebble diameters (mm)[2] sampled										Notes
	1	2	3	4	5	6	7	8	9	10	
2											
4											
6											
8											
10											
12											
14											
16											
18											
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44											
46											
48											
50											
52											
54											
56											
58											
60											
62											
64											
66											

[2] If the substrate particle is too small to measure, record as “silt” or “sand.” Otherwise record the diameter (region of greatest dimension) of the particle to the nearest millimeter.

68											
70											
72											
74											
76											
78											
80											

Part 4: Residual Pool Depth and Frequency

Stream:				Date:	
Monitoring Area:					
Distance between riffle crest & pool bottom	Depth of riffle crest or pool bottom	Riffle crest (R) or pool bottom (P)	Distance between riffle crest & pool bottom	Depth of riffle crest or pool bottom	Riffle crest (R) or pool bottom (P)
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**
		P			**P**
		R			**R**

		P			**P**
		R			**R**
		P			**P**

Notes & Observations:

LSSC Monitoring Plan, Appendix I Attachment 8: Guidelines for Selection of Areas to Monitor Stream Conditions

Background

Resource experts from US Bureau of Land Management, US Forest Service, and Trout Unlimited were asked to identify aquatic/riparian monitoring locations for the LaSal Sustainability Plan. Several emails were exchanged throughout June 2016 to determine site selection criteria followed by a meeting at the Moab BLM office on July 15, 2016, to pinpoint locations on maps for monitoring and to determine whether further field verification of sites was needed.

Site Selection Criteria

Sites were selected based on the following criteria in order of importance.

1. Cattle are expected to graze the site.
2. Proximity to existing suitable sampling locations
3. Reasonably accessible from a road with a short walk or hike.
4. Perennial water flow allowing for sampling of aquatic organisms as well as riparian vegetation.

Other criteria[1] also considered in the selection of monitoring sites included:

- Streambed gradient (ideal locations would have a low gradient and would have a variety of geomorphic features such as polls and riffles)
- Streambank substrate composition (materials typically held in place by vegetation)
- Proximity to infrastructure that would uncharacteristically concentrate livestock (i.e., select sites not influenced by water troughs, fences, etc.)

Sites Selected and Notes

US Forest Service

- Deer Springs

  Location: 655676 E 4247848 N (UTM NAD83) or nearby.

  There is currently a greenline trend site located near the exclosure around the spring with data already available. It is easily accessible by road with a possible small hike.

- LaSal Creek

  Location: 655102 E 4251636 N (UTM NAD83) or nearby.

[1] The first two "other criteria" provide priority for monitoring sites *that would be sensitive to grazing management*.

This site is easily accessible by road near a road crossing. There is currently a greenline trend site located near with data already available. It is located in an open flat area that fit the criteria for monitoring site selection.

- Beaver Creek

  Location: 659948 E 4250388 N (UTM NAD83) or nearby.

  There is an existing flow monitoring site with a greenline trend location nearby. It is accessible by road with a possible short hike and is open enough to complete monitoring survey work.

Bureau of Land Management

- Three Mile Creek

  Location: 632697 E 4236788 N (UTM NAD83)

  There are two water quality monitoring locations at or near the Three Mile monitoring site we selected. The site is near the confluence of Three Mile and Hatch Wash and is close to the Little Water/Hatch wash confluence. This area has some previous monitoring data and is accessible by a short hike. The presence of fish is questionable but the lower end of the drainage has perennial flow and would be suitable for riparian monitoring.

- Cottonwood Creek

  Location: 643756 E 4246474 N (UTM NAD83)

  The aquatic riparian group selected a site at the boundary of Forest Service and BLM allotments. The site has no previously recorded sample data but is easily accessible by short hike from the road. The site should be located near the private land/BLM boundary and before water is diverted from the stream.

- Muleshoe Creek

  Location: 634357 E 4248787 N (UTM NAD83)

  The area is used by cattle; however, stream flow may be intermittent. There may be value in monitoring riparian conditions only in Muleshoe Creek.

- West Coyote Creek

  Location: 640670 E 4240771 N (UTM NAD83)

  Easily accessible from the road for monitoring and is used by cattle when they are in this portion of the allotment. Perennial flow.

- Trout Water

  Location: 625179 E 4243339 N (UTM NAD83)

  Easily accessible by road and there is at least one water quality monitoring location nearby.

LSSC Monitoring Plan, Appendix I Attachment 9. Deeply Rooted Species that Contribute to Streambank Stability

The following table is based on a list of riparian vegetation compiled by the Utah Riparian Service Team (RST) to assess *Proper Functioning Condition* stability class ratings. All species classified by the RST Team as having a high stability class are included, however the list is not intended to be all inclusive. By definition, herbaceous plants with a high stability classification are deep-rooted and have long, stout, well-developed rhizomes and fibrous roots; woody species with a high stability classification are deep-rooted, and have long, spreading, well developed root systems.

This list includes several non-native species (highlighted in blue) that functionally contribute to streambank stability, and will be credited for doing so for the purposes of the associated monitoring indicator. However, native species are preferred; where possible we will seek to replace non-native with native species that are deeply rooted.

Growth Form	Scientific Name	Common Name
Forbs	*Caltha leptosepala*	white marsh marigold
	Typha angustifolia	narrowleaf cattail
	Typha domingensis	southern cattail
	Typha latifolia	broadleaf cattail
	Urtica dioica	stinging nettle
	Veratrum caifornicum	California false hellebore
Grasses	*Arundo donax*[1]	giant reed
	Calamagrostis canadensis	blue-joint
	Elymus cinereus	basin wildrye
	Glyceria grandis	American mannagrass
	Phalaris arundinacea	Reed canary grass
	Phragmites australis[2]	common reed
	Spartina gracilis	alkali cordgrass
	Spartina pectinata	prairie cordgrass
Grass-Like Species	*Bolboschoenus maritimus*	cosmopolitan bulrush
	Carex amplifolia	bigleaf sedge
	Carex aquatilis	water sedge
	Carex atherodes	wheat sedge
	Carex lasiocarpa var. americana	American woollyfruit sedge
	Carex nebrascensis	Nebraska sedge
	Carex pellita	woolly sedge
	Carex praegracilis	clustered field sedge
	Carex rostrata	beaked sedge
	Carex saxatilis	rock sedge
	Carex scopulorum	mountain sedge

[1] This species is listed on the Utah Noxious weed list. The giant reed is a Class 1B EDRR species.
[2] This species is listed on the Utah Noxious weed list.

	Carex sheldonii	Sheldon's sedge
	Carex simulata	analogue sedge
	Carex utriculata	Northwest Territory sedge
	Carex vesicaria	blister sedge
	Juncus arcticus	arctic rush
	Juncus arcticus ssp. Littoralis	mountain rush, baltic rush
	Juncus torreyi	Torrey's rush
	Schoenoplectus acutus	hardstem bulrush
	Schoenoplectus americanus	chairmaker's bulrush
	Schoenoplectus pungens	common threesquare
	Schoenoplectus tabernaemontani	softstem bulrush
	Scirpus microcarpus	panicled bulrush
	Scripus nevadensis	Nevada bulrush
Shrubs	*Baccharis emoryi*	Emory's baccharis
	Baccharis salicifolia	mule-fat
	Cornus sericea ssp. sericea	redosier dogwood
	Rhamnus alnifolia	alderleaf buckthorn
	Salix arizonica	Arizona willow
	Salix bebbiana	Bebb willow
	Salix boothii	Booth's willow
	Salix dummondiana	Drummond's willow
	Salix geyeriana	Geyer willow
	Salix laevigata	red willow
	Salix lasiolepis	arroyo willow
	Salix lemmonii	Lemmon's willow
	Salix lucida	shining willow
	Salix lucida ssp. lasiandra	Pacific willow
	Salix lutea	yellow willow
	Salix monticola	park willow
	Salix planifolia	diamondleaf willow
	Salix prolixa	MacKenzie's willow
	Salix scouleriana	Scouler's willow
	Salix wolfii	Wolf's willow
	Tamarix chinensis	five-stamen tamarisk
	Tamarix parviflora	smallflower tamarisk
	Tamarix ramosissima[3]	saltcedar
Trees	*Acer negundo*	boxelder
	Alnus incana	gray alder
	Betula glandulosa	resin birch
	Betula occidentalis	water birch
	Crataegus succulanta	fleshy hawthorn
	Juglans major	Arizona walnut
	Populus angustifolia	narrowleaf cottonwood

[3] This species is listed on the Utah Noxious weed list.

	Populus balsamifera	balsam poplar
	Populus deltoides	eastern cottonwood
	Populus fremontii	Fremont cottonwood
	Populus tremuloides	quaking aspen
	Populus balsamifera ssp. trichocarpa	black cottonwood
	Prunus virginiana	chokecherry
	Salix amygdaloides	peachleaf willow
	Salix gooddingii	Goodding's willow

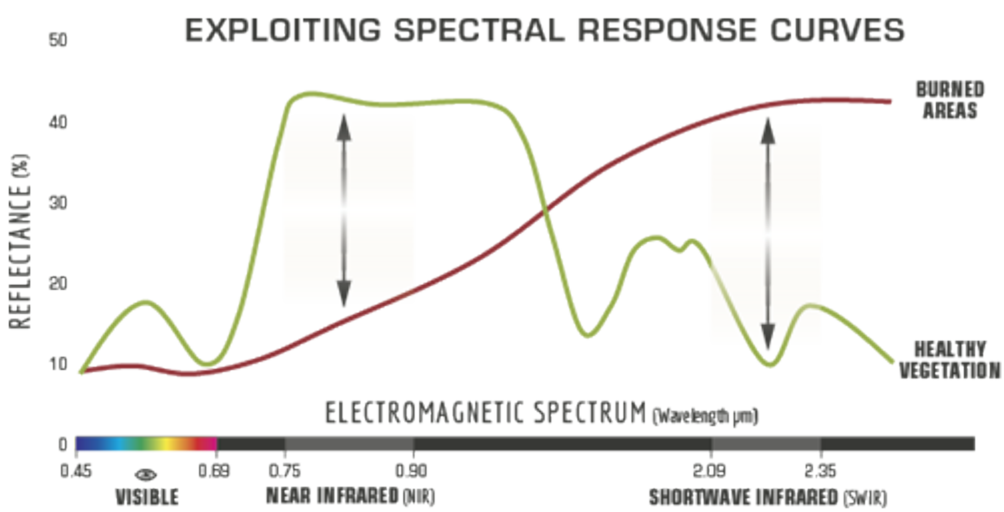
LSSC Monitoring Plan, Appendix I Attachment 10. Burned Area Reflectance Classification (BARC)

What is a BARC?

A Burned Area Reflectance Classification (BARC) is a satellite-derived data layer of post-fire vegetation condition. The BARC has four classes: high, moderate, low, and unburned. This product is used as an input to the soil burn severity map produced by the Burned Area Emergency Response (BAER) teams.

How is BARC data generated?

BARC data is made by comparing satellite near and mid infrared reflectance values. The logic behind the process is as follows:



- Near infrared light is largely reflected by healthy green vegetation. That means that near infrared bands will be very high in areas of healthy green vegetation and low in areas where there is little vegetation.
- Mid infrared light is largely reflected by rock and bare soil. That means that mid infrared band values will be very high in bare, rocky areas with little vegetation and low in areas of healthy green vegetation.
- Imagery collected over a forest in a pre-fire condition will have very high near infrared band values and very low mid infrared band values. Imagery collected over a forest after a fire will have very low near infrared band values and very high mid infrared band values.

For more information see Spectral_Reflectivity_Overview.pdf.

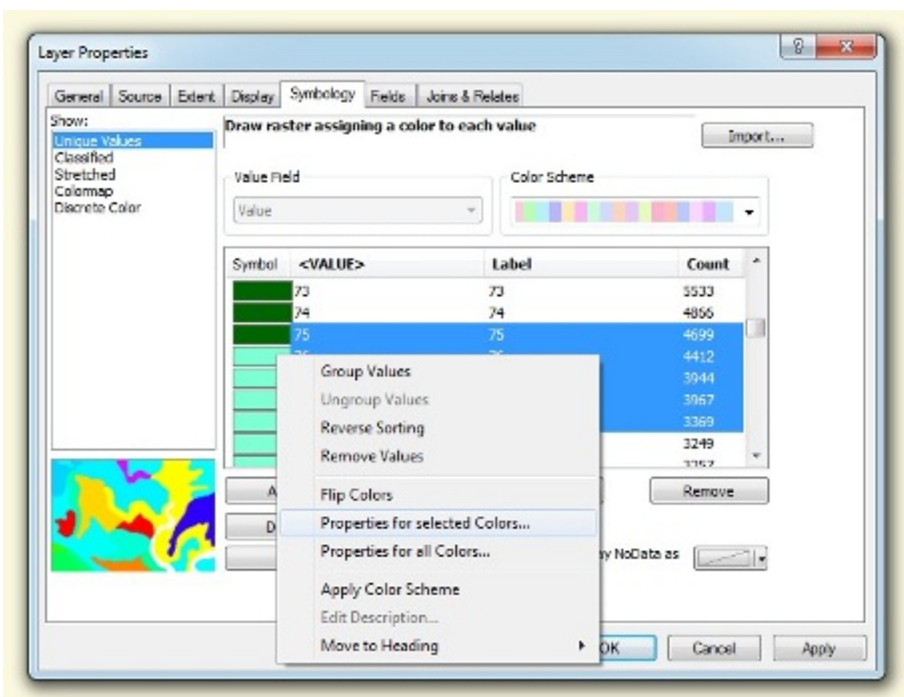
It is the relationship between these two bands that the BARC attempts to exploit. The best way to do this is to measure the relationship between these bands prior to the fire and then again post fire. The areas where the relationship between the two bands has changed the most are most likely to be severely burned. The areas where that relationship has changed little are likely to be unburned or very lightly burned. To determine this relationship, analysts perform a band ratio between the mid and near infrared bands. The result is a classification of burned areas.

<u>How should BARC data be used?</u>

In the immediate aftermath of a wildfire, a Forest Service Burned Area Emergency Response (BAER) team is dispatched to the site to prepare an emergency rehabilitation and restoration plan. They do this by making an initial assessment of soil burn severity and to estimate the likely future downstream impacts due to flooding, landslides, and soil erosion. One of the first tasks for this team is the creation of a soil burn severity map that highlights the areas of high, moderate, and low severity. This map then serves as a key component in the subsequent flood modeling and Geographic Information System (GIS) analysis. The BARC data is meant to be used as a main input into the development of the final soil burn severity map.

<u>What is the BARC256 and how do I use it?</u>

In addition to delivering the 4-class BARC data to field teams, RSAC also provides field users a continuous 256-class version of the BARC. This is called the BARC256. This data set provides users the ability to adjust the break points between reflectance classes. Analysts at RSAC will color code the BARC256 image using the same classification scheme used for the BARC4 data, but the BARC256 will not be recoded into 4 classes.



The color-coding on the BARC256 done by RSAC is meant to act as a starting point for field team members. Users can view the color scheme and adjust these break points as desired. This can easily be done in ArcMap. For step-by-step instructions on making break point adjustments, please refer to the document Editing BARC Data Layers substituting your data in place of the data listed in the exercise.

The data will also typically be sent as a square or rectangular subset that covers land outside the fire perimeter. This can easily be clipped to the fire perimeter of choice using ArcMap's Spatial Analyst extension.

Who do I contact to get BARC data?

The Forest Service Remote Sensing Applications Center (RSAC) and the US Geological Survey Center for Earth Resources Observation and Science (EROS) both provide satellite imagery and BARC data services to BAER teams responding to wildfire incidents. RSAC is responsible for imagery and BARC support requests for wildfires on Forest Service lands, while EROS is responsible imagery and BARC support on all Department of Interior lands. Imagery and BARC support is available on a cost reimbursable basis for wildfires occurring on Forest Service lands where a BAER team is not deployed, or for prescribed fires.

For more information, see http://www.fs.fed.us/eng/rsac/baer/.

LSSC Monitoring Plan, Appendix I Attachment 11: Undesirable Species

The following are lists of species considered undesirable by all collaborators.

State Noxious Weeds

All land managers are required, by State of Utah law, to actively control noxious weeds. Noxious weeds represent species that harm public health, agriculture, recreation, wildlife or property. Grand County has adopted only the state noxious weeds, but San Juan County has listed two species in addition to the state list (see below).

Common Name	Scientific Name
African mustard	*Brassica tournefortii*
African rue	*Peganum harmala*
Bermudagrass	*Cynodon dactylon*
Black henbane	*Hyoscyamus niger*
Blueweed (Vipers bugloss)	*Echium vulgare*
Camelthorn	*Alhagi maurorum*
Canada thistle	*Cirsium arvense*
Cogongrass (Japanese blood grass)	*Imperata cylindrica*
Common crupina	*Crupina vulgaris*
Common St. Johnswort	*Hypericum perforatum*
Cutleaf vipergrass	*Scorzonera laciniata*
Dalmation toadflax	*Linaria dalmatica*
Dames Rocket	*Hesperis matronalis*
Diffuse knapweed	*Centaurea diffusa*
Dyers woad	*Isatis tinctoria*
Elongated mustard	*Brassica elongata*
Field bindweed (Wild Morning-glory)	*Convolvulus* spp.

Common Name	Scientific Name
Garlic mustard	*Alliaria petiolata*
Giant reed	*Arundo donax*
Goatsrue	*Galega officinalis*
Hoary cress	*Cardaria* spp.
Houndstounge	*Cynoglossum officianale*
Japanese knotweed	*Polygonum cuspidatum*
Jointed goatgrass	*Aegilops cylindrica*
Leafy spurge	*Euphorbia esula*
Malta starthistle	*Centaurea melitensis*
Mediterranean sage	*Salvia aethiopis*
Medusahead	*Taeniatherum caput-medusae*
Musk thistle	*Carduus nutans*
Myrtle spurge	*Euphorbia myrsinites*
Oxeye daisy	*Leucanthemum vulgare*
Perennial pepperweed (Tall whitetop)	*Lepidium latifolium*
Perennial sorghum spp.:	
Johnson Grass	*Sorghum halepense*
Sorghum almum	*Sorghum almum*
Phragmites (Common reed)	*Phragmites australis* ssp.
Plumeless thistle	*Carduus acanthoides*
Poison hemlock	*Conium maculatum*
Puncturevine (Goathead)	*Tribulus terrestris*

Common Name	Scientific Name
Purple loosestrife	*Lythrum salicaria*
Purple starthistle	*Centaurea calcitrapa*
Quackgrass	*Elymus repens*
Rush skeletonweed	*Chondrilla juncea*
Russian knapweed	*Acroptilon repens*
Russian olive	*Elaeagnus angustifolia*
Scotch broom	*Cytisus scoparius*
Scotch thistle (Cotton thistle)	*Onopordum acanthium*
Small bugloss	*Anchusa arvensis*
Spotted knapweed	*Centaurea stoebe*
Spring millet	*Milium vernale*
Squarrose knapweed	*Centaurea virgata*
Syrian beancaper	*Zygophyllum fabago*
Tamarisk (Saltcedar)	*Tamarix ramosissima*
Ventenata (North Africa grass)	*Ventenata dubia*
Yellow starthistle	*Centaurea solstitialis*
Yellow toadflax	*Linaria vulgaris*

San Juan County Noxious Weeds (in addition to state weeds)

Common Name	Scientific Name
Buffalobur	*Solanum rostratum*
Whorled milkweed	*Asclepias verticillata*[1]

Other Undesirable Species

The following is a list of plant species that the members of the collaboration have identified as undesirable.

Common Name	Scientific Name
Annual bursage	*Ambrosia acanthicarpa*
Annual ragweed	*Ambrosia artemisiifolia*
Broom snakeweed	*Gutierrezia sarothrae* (when common)
Bulbous bluegrass	*Poa bulbosa*
Bull Thistle	*Cirsium vulgare*
Cactus	*Opuntia* spp. (when common)
Canadian horseweed	*Conyza canadensis*
Cheatgrass	*Bromus tectorum*
Common dandelion	*Taraxacum officinale*
Common plantain	*Plantago major*
Common purslane, little hogweed	*Portulaca oleracea*
Halogeton, saltlover	*Halogeton glomeratus*

[1] Note that *Asclepias verticillata* is native in Utah, and is a common late-season host plant for monarch butterflies, which are in significant decline due to habitat loss, development, and herbicides: http://monarchwatch.org/bring-back-the-monarchs/milkweed/milkweed-profiles/asclepias-verticillata/.

Common Name	Scientific Name
Kentucky bluegrass	*Poa pratensis*
Ravenna grass	*Saccharum ravennae*
Russian thistle	*Salsola* spp.
Kochia, burning bush	*Bassia scoparia*
Prickly lettuce	*Lactuca serriola*
Rabbitbrush	*Chrysothamnus, Ericameria* spp. (when common/dominant)
Reed canary grass	*Phalaris arundinacea*
Rocky Mountain iris	*Iris missouriensis* (when common or dominant; excludes natives)
Rough cocklebur	*Xanthium strumarium*
Smooth brome	*Bromus inermis* (when common; excludes natives)
Tamarisk	*Tamarix* spp.
Twoneedle pinyon	*Pinus edulis (Undesirable at those sites where it was not historically present[2]. Where present at or near monitoring sites during baseline data gathering, the collaboration will continue to monitor its presence in the future.)*
Utah juniper	*Juniperus osteosperma (Undesirable at those sites where it was not historically present[1]. Where present at or near monitoring sites during baseline data gathering, the collaboration will continue to monitor its presence in the future.)*

[2] USDA-NRCS. (2014). *Pinyon and Utah Juniper Site Evaluation Procedure for Utah*. Technical Note. https://efotg.sc.egov.usda.gov/references/public/UT/Pinyon_and_Utah_Juniper_Evaluation_Procedure_12-2014.pdf.

APPENDIX J. LSSC Recommended Adaptive Management Strategy

Adaptive management (AM) is a structured, iterative process of decision making with an aim to reduce uncertainty over time via systematic monitoring. Direction and guidance for implementation of AM for grazing permits/authorizations is incorporated in agency policy (Bureau of Land Management – DOI Manual Section 522 DM 1, February 1, 2008; Forest Service – Permit Administration Handbook, FSH 2209.13, Chapter 90, section 92.23b). This process provides for timely adjustments or "course corrections" to management actions incorporated in the agencies' decisions toward attainment of desired conditions and objectives.

The AM process does not apply to willful or obvious violations of grazing permit/authorization terms and conditions, but applies to situations where qualitative and/or quantitative *indicators* suggest a potential need for management changes. The action taken by managers is directly related to the degree of the situation indicating a need for change. The AM process does not alter the agencies' authority to implement adverse actions against permittees who violate terms and conditions of grazing permits/authorizations.

Strategy Framework

The La Sal Sustainability Collaboration (LSSC) is committed to co-discovering approaches to uses of the Southern La Sal Mountains and adjoining Canyonlands that are socially, economically, administratively, and ecologically sustainable. The consensus recommendations of the LSSC reflect agreement of members of the collaboration to use the best available science in one approach to grazing management. We understand there is much yet to be learned and expect that adjustments will be needed over time to optimize outcomes in each of the four dimensions of sustainability. We are committed to continue to work together to identify and guide changes in management that will enhance sustainability within the LSSC geography. To that end a suite of *desired conditions, indicators* of sustainability, and associated *discussion prompts* is recommended against which to measure the efficacy of management and guide adjustments as warranted (found in **APPENDIX I** -- Monitoring Plan, **Table 1**).

Desired Conditions. *Desired conditions* are a statement of what the land is being managed toward, or our recommended goals for the LSSC landscape. They are presented in terms of social, economic, administrative, and ecological dimensions of that landscape.

Quantitative Indicators. To evaluate progress toward each of the *desired conditions* and inform management changes we have sought to identify *quantitative indicators* that are most sensitive to management changes. These *quantitative indicators* will be periodically assessed at a network of monitoring sites across the LSSC landscape to provide trend information. Methodology, location, timing, frequency and responsibility for collection and analysis of data are detailed in the LSSC Monitoring Plan (**APPENDIX I**).

At a subset of the 30 monitoring locations (i.e., 7 sites) we will use exclosures to help provide insight into:

- Ecological potential absent domestic livestock grazing
- Ecological potential absent all ungulate grazing
- Rates of change in ecological conditions with and without ungulate grazing
- Relative influence of climate/weather and other sources of system disturbance

Comparable data will be collected, per the described methodology, inside and outside the exclosures at these sites.

Qualitative Indicators. Although *quantitative indicators* are essential to assessing progress and promoting accountability for attainment of our *desired conditions* we recognize that in the harsh LSSC environment, some measurable changes in sustainability due to management changes may only be conclusively detected over relatively long periods of time. Therefore we believe *qualitative indicators* also have an important role to play in adaptive management of this landscape. In this context, *qualitative indicators* include *any observable (but potentially difficult to measure) condition or situation* within the LSSC geography that may place our sustainability goals at risk.

One type of *qualitative indicator* of particular importance to the success of the LSSC is *real-time adjustment of grazing duration by pasture* (**APPENDIX E**). The LSSC recognizes the need for observable *indicators* that will inform livestock movement from one pasture into the next. Although the duration of grazing will be estimated before the animals enter a particular pasture, these *indicators* will be used to guide lengthening or shortening grazing duration based on ecological condition and functionality of the pasture.

Discussion Prompts. For each of the *quantitative indicators* we have established *trend* and/or *numeric value* discussion prompts. These values typically represent *objectives* toward which we are managing rather than hard *standards*. In a few cases these *discussion prompts* are based on regulatory standards (e.g., water quality); in most cases they represent conditions the diverse membership of the LSSC believes enable or represent ecosystem sustainability. Where *discussion prompts* are framed as a "% similarity of improvement," they only apply to those monitoring sites where exclosures are being used for comparison purposes.

Implementation/Application

Recommendations for adaptation of management practices will emerge through dialogue among members of the LSSC and our agency advisors in response to: 1) success or failure to meet established *discussion prompts* for the *quantitative indicators of social, economic, administrative, and/or ecological sustainability;* 2) *qualitative indicators* that suggest our sustainability goals are at risk; and/or 3) *other information* (e.g. emerging science, data collected by the land management agencies or the producers' consultant). Dialogue will be used to make sense of data at the semi-annual meeting of the LSSC – with an intention of deepening understanding of what may be influencing the results (e.g., the management prescription itself, failure to follow the management prescription, inadequate grazing infrastructure to insure appropriate use of the pastures, climatic or other environmental stressors) and what changes might contribute to meeting the *desired conditions*. Where desired conditions are not being met, members of the LSSC will, when feasible, recommend adaptive management changes from the potential specific management action categories listed below or other management actions.

Monitoring is absolutely essential to the success of the LSSC, and without monitoring the effectiveness of specific management actions cannot be determined. In instances where monitoring to which an LSSC member committed is not performed by that member as scheduled, a note of that deficiency will be made to the appropriate agency and distributed to all LSSC members for discussion, along with the recommendations as to how to complete the monitoring as soon as possible.

Quantitative Indicators – Trend. Recommendations for adaptation of management practices may be based on multi-year trends that depart from the associated *desired condition*. In addition, point in time measurements of *quantitative indicators* may surface information worthy of dialogue at the semi-annual meetings of the LSSC regarding the potential need to recommend adjustments in management ahead of data driven, statistically significant conclusions about trends. Strategies to address trends that depart from desired conditions and quantitative indicators that fall short of identified discussion points will result in recommendations for one or more changes from the potential specific management action categories listed below or other management actions. The specific action to be recommended will be developed through dialogue within the LSSC.

Quantitative Indicators – Numeric Value. Recommendations for adaptation of management practices may be based on departure from identified numeric value discussion prompts. Such departures will prompt dialogue at the semi-annual meetings of the LSSC. Strategies to address departures from these numeric values will result in recommendations for one or more changes from the potential specific management action categories listed below or other management actions. The specific action to be implemented will be developed through dialogue within the LSSC.

Real-Time Adjustment of Grazing Duration (See **APPENDIX E** for additional detail). Seasonal use of key grass and woody species will be visually estimated in areas grazed by livestock using landscape appearance descriptors to inform the duration of livestock grazing in each pasture. Examiners making these estimates must think in terms of the key sites within the pasture.

At five high or moderate ecological integrity pastures each year, a utilization cage will be used and key native grasses will be clipped and weighed within one week of pasture exit for quantitative calibration of visual estimates with measured use. The utilization cages will be rotated through different pastures every year unless the clip-and-weigh indicates a particular pasture was 10% over the estimated seasonal use, in which case the pasture will again contain a clip-and-weigh cage the following year. A utilization cage followed by clip-and-weigh within one week of the date of pasture exit will be placed annually in each low integrity pasture. Results of clip-and-weigh will be retained in the pasture record.

If there are additional areas of concern in a given pasture, use in these areas should also be taken into consideration. In pastures where no LSSC monitoring sites exist, key areas for seasonal use estimation will be designated.

Key species (determined by the LSSC) will be evaluated periodically by the producers' riders and/or range consultant while the pasture is being grazed. Others (e.g., agency personnel, other LSSC members) are encouraged to share seasonal use observations with the producers and agencies to ensure that livestock movement occurs promptly when use begins to meet the desired levels.

Livestock movement will be initiated when seasonal use of key species in the key area(s) of the pasture reach defined levels. This will ensure that, by the time all of the livestock are successfully removed from the pasture, the vigor of key species will not be compromised by excessive defoliation. Qualitative observations of livestock behavior may also suggest the need to move livestock to the next pasture ahead of schedule. For example, if cattle are observed to be reusing plants that have already been grazed, returning to specific areas of a pasture, or are "banking" against pasture fence lines advancing the rotation schedule may be appropriate. Moving livestock to the next pasture on a rain event within a week of a scheduled rotation may also be appropriate to promote plant vigor.

In addition to these qualitative approaches to real-time prompts, the producers' consultant has historically collected some quantitative data on seasonal use (i.e., by measuring plant weight prior to livestock entry into a pasture, during use of the pasture, at the end of livestock use, and at the end of the growing season). Typically this effort is invested only where there are concerns about the level of use. Where this data is collected it may be used, in addition to the qualitative indicators to inform modification of the rotation schedule.

<u>Qualitative Indicators</u>. As noted above, *qualitative indicators* include *any observable condition or situation* within the LSSC geography that may place our *desired conditions* at risk. In practice, LSSC members will document their concerns on an on-going basis for discussion with one another and agency advisors at semi-annual meetings of the Collaboration (e.g., with a geo-referenced photo and brief narrative description). Other members of the public can similarly document qualitative concerns, and provide them to the agencies who will convey such documentation to the LSSC. We are committed to our sustainability goals and therefore interested in daylighting all concerns and learning together from discussion of those concerns.

<u>Other Information</u>. We expect AM of the LSSC landscape to be informed by emerging science and data collected by the land management agencies, the producers' consultant, the Utah Division of Wildlife Resources and other entities. Participants at the semi-annual meeting of the LSSC will be encouraged to share such information to help inform AM.

Although the preceding material describes unique categories that signal a potential need for AM, they are more powerful when considered in whole. The LSSC will consider all of these *signals* and work toward consensus agreement on recommended adjustments to management (if any appear appropriate) and document the rationale for their recommendations.

Specific Management Actions

It is challenging to identify specific management changes that may be informed by: 1) success or failure to meet established *discussion prompts* for the *quantitative indicators of social, economic, administrative, and/or ecological sustainability;* 2) *qualitative indicators* that suggest our sustainability goals are at risk; and/or 3) *other information* (e.g., emerging science, data collected by other entities or the producers' consultant) – however, we can anticipate categories of potential actions to enhance social, economic, administrative, and/or ecological sustainability and reasonable examples for each. These are briefly summarized below.

<u>Potential Changes in Livestock Management</u>

- Numbers permitted/authorized[1]
- Time and timing of forage use
- Class of livestock grazed
- Need for additional or different grazing infrastructure
- Need for additional or different herding practices

<u>Potential Changes in Other Land Management Activities</u>

- Recreation and Interpretation
- Roads and Trails
- Vegetation
- Wildland Fire

<u>Potential Changes in Administrative Practices</u>

<u>Potential Changes in Wild Ungulate Management</u>

- Reduction in herd size

<u>Potential Changes in Expectations</u>[2]

- Desired Conditions
- Indicators
- Discussion Prompts

Although some potential future management changes will require additional National Environmental Policy Act (NEPA) analysis at the time they become evident, we encourage the

[1] These adjustments may represent increases associated with reinstatement of suspended AUMs (when desired conditions are being met) or decreases in AUMs (where determined necessary to meet desired conditions).

[2] As we gather more information and deepen our understanding, there may be a need to reframe *desired conditions, indicators, and discussion prompts* to more accurately reflect the potential of this landscape.

land management agencies to evaluate such AM actions – to the fullest extent possible – in the NEPA processes they are undertaking to modify and transfer current permits/authorizations. Doing so will provide flexibility for timely “course corrections” to management actions incorporated in the agencies’ decisions and foster attainment of *desired conditions* outlined in this AM Strategy.

Appendix K. Sample Agenda for Semi-Annual Meetings of the LSSC

La Sal Sustainability Collaboration (LSSC) Agenda

DATE: [Monday, June 19th, 2017]
TIME: [10:00 a.m. – 3:00 p.m.]
LOCATION: [Grand County Public Library Board Room]

LSSC Semi-Annual Meeting Co-Conveners:

- La Sal Livestock
- UT Grazing Improvement Program
- Grand Canyon Trust

Invited Meeting Participants:[1]

- LSSC Members
  - BLT Cattle Co.
  - Grand Canyon Trust
  - La Sal Livestock Co.
  - San Juan County
  - Sierra Club
  - Trout Unlimited
  - UT Division of Wildlife
  - UT Grazing Improvement Program
- Resource Experts
  - Bureau of Land Management (BLM)
  - Natural Resources Conservation Service (NRCS)
  - San Juan Soil Conservation District
  - School Institutional Truste Land Administration (SITLA)
  - US Fish & Wildlife Service (F&WS)
  - US Forest Service (FS)

[1] For openness and transparency purposes, LSSC semi-annual meetings will be open to the public and advertised 4-6 weeks in advance in the *Moab Times-Independent* and *San Juan Record*. Time will be provided at the beginning of each meeting for public comments, to maximize the opportunity for those comments to inform the LSSC meeting.

Semi-annual meeting objectives: [2]

- Evaluation, refinement, and implementation of LSSC Consensus Recommendations
- Review of monitoring conducted and other relevant data gathered since last LSSC meeting
- Discussion of adaptive management actions (if any)
- Identification of next steps, assignments of responsibility and timelines
- Scheduling/confirmation of next LSSC meeting

Menu of Possible Agenda Items:[3]

Introductions

Operating Protocols (Brief review for new members or if needed)

Public Comments (limited to 30 minutes (or xx minutes per person, if there are more than 5 individuals wishing to provide comment)

Observations on implementation of Management Action recommendations (Give updates on actions taken to implement recommendations since last meeting and any challenges encountered)

- Pasture rotation and schedule for year (Final Report Section II.A.1.a-d)
  - BLM
  - FS
  - Summary of real time adjustments made in movement of livestock among pastures
  - Modifications needed (if any)
- Infrastructure Installment and funding (Final Report Section II.A.1.e)
- Native fish (Final Report Section II.A.2)
- Beaver (Final Report Section II.A.3)
- Upland forest health (Final Report Section II.A.4)
- Wildfire (Final Report Section II.A.5)
- Soil erosion (Final Report SectionII.A.6)
- High value areas (Final Report Section II.A.7)
- Social conflicts (Final Report Section II.A.8)

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[2] The LSSC's Final Report and Consensus Recommendations included a commitment by all LSSC members to "stay engaged in the evaluation, refinement, and implementation of our recommendations, and ongoing assessment and improvement of management of this landscape." Meetings will initially be held semi-annually, in early December and mid-June of each year.

[3] The LSSC co-conveners will solicit input from the invited meeting participants at least two weeks before each semi-annual meeting to identify specific items to be included in that meeting's agenda. It is not anticipated that each semi-annual meeting will cover every item in this menu of possible agenda items.

- Pack Creek residential area
- Gates to encourage closing by all users
- Fences moved or gates replaced with cattleguards to eliminate conflicts with other users
- Public information about grazing on public lands

Observations on Implementation of Administrative Action recommendations

- Operational issues (Final Report Section II.B.1)
  - Elimination of permit gap
  - Timely permit/authorization transfers
  - Timely permit/authorization modifications
- Regulatory status of cutthroat (Final Report Section II.B.2)
- Communication (Final Report Section II.B.3)

Observations on Assessment of Progress and Accountability (Discuss monitoring results relative to desired conditions, indicators and discussion prompts, and assess need for modification of management recommendations)

- Monitoring schedule (Discuss any issues/problems with the monitoring schedule or protocols) (Final Report Section II.C.2)
- Social Sustainability (Final Report Section II.C.1, Appendix I)
  - Conflict over the presence of cattle in Pack Creek residential areas **(**Status of formalized agreement)
  - Interaction among various public land multiple uses result in diminishment of values important to those users (Number and nature of complaints per year/Decreasing?)
  - Opportunity for future generations to graze livestock on public lands (Sense of the group)
- Economic Sustainability (Final Report Section II.C.1, Appendix I)
  - Costs associated with management (private and public)
    - Inflation adjusted producer costs of management (relative to production)
    - Economic return to society on public and private investment
  - Production quantity and reliability
    - Pounds of weaned calf per cow exposed
    - AUMs grazed relative to permitted or authorized numbers
  - Water distribution, cross-fencing, and other infrastructure to effectively manage livestock
    - Progress toward prioritized list of identified infrastructure improvements

    - Other economic benefits
        - Water quantity/value
        - Wildfire suppression and rehabilitation costs
        - Wildfire damage to built infrastructure ($$$)
        - Size/quantity of trout
- Administrative Sustainability (Final Report Section II.C.1, Appendix I)
    - Permit or Authorization transfer, modification, and compliance
        - Timing of permit and authorization transfer and modification
        - Number and nature of compliance issues/year
    - Inter- and intra-agency coordination and communication with permittees
        - Number/year of surprises/conflicts related to grazing within the LSSC area
            - Between agencies
            - Within agencies
        - Number/year of surprises resulting from inadequate communication from
            - Permittees
            - Agency Personnel
- Ecological Sustainability (Final Report Section II.C.1, Appendix I)
    - Biological Diversity of Native Flora
        - Composition and Cover by Species
            - Grass Communities
            - Sagebrush Communities
            - Aspen Communities
            - Riparian Communities
            - Mountain Brush Communities
        - Vigor (Seedhead Production, Recruitment, and Leader Growth)
            - Grass Communities
            - Sagebrush Communities
            - Aspen Communities
            - Riparian Communities
            - Mountain Brush Communities
        - Stream habitat is occupied by native fish assemblages
            - Miles of stream with self-supporting native fish assemblages
    - Watershed Health – Riparian/Aquatic
        - Water quality meets or exceeds state and federal requirements
            - Temperature
            - Nutrient
            - Dissolved Oxygen
            - Macroinvertebrate Community Composition
        - Water quantity is maintained or increased
            - Deer Springs Creek
            - La Sal Creek
            - Beaver Creek

- Riparian/aquatic habitats are highly functional and resilient
    - Acres and condition of riparian areas
    - Mechanical trampling/shearing of streambanks
    - Portion of streambanks with deeply rooted vegetation
    - Pool length and depth
    - Sedimentation of Substrate
    - Macroinvertebrate community composition
    - Number of springs protected
- Watershed Health – Uncharacteristic Wildfire
    - Fuel Loading
- Watershed Health – Other (Soil Characteristics and Undesirable Species)
    - Soils are stable and improving (Indicators)
    - Undesirable plant species have little or no influence on ecological functionality

Other Issues (if any)

Acknowledgement of Special Contributions (Recognize the special achievements of members and resource experts)

Next Steps (Confirm/summarize next steps, assignments of responsibility, timelines)

- Set date for next semi-annual meeting
- Confirm advertising deadline for next semi-annual meeting

Adjournment