The Potential for Conservation Grazing in Coastal Uplands

RESEARCH AND DEVELOPMENT PLAN

MISSISSIPPI STATE UNIVERSITY EXTENSION
Sea Grant MISSISSIPPI-ALABAMA
Grand Bay National Estuarine Research Reserve
Weeks Bay Reserve
Apalachicola National Estuarine Research Reserve
TEXAS A&M UNIVERSITY
MISSION-ARANSAS NATIONAL ESTUARINE RESEARCH RESERVE

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Summary

Along the Gulf of Mexico (GoM) coast, natural resource managers continually struggle with managing coastal uplands due to front-end costs, prolonged maintenance, and habitat-specific ecological needs. Prescribed fire, mechanical removal, and chemical treatments are common habitat management techniques used to remove invasive species, clear understory, and achieve other management goals. However, rapid development and changing climate exacerbate the difficulty in using these techniques. A potential alternative or complementary technique is using livestock for habitat management (i.e., targeted or controlled grazing). In other regions of the world, using livestock for conservation or restoration of managed lands has shown to be a less intrusive and more financially viable alternative. As part of a currently funded NOAA RESTORE Science Program planning grant, a survey was developed and distributed to natural resource managers in the region with the goal of understanding the research needs, logistical, and environmental concerns related to using livestock for habitat management in the coastal uplands of the GoM. Survey results showed that over 96% of natural resource managers were interested in using livestock for habitat management, but none were aware of research-based information that could be used to inform grazing practices for coastal upland habitat management in this region. Furthermore, natural resource managers that participated in the survey and on the project team identified specific research questions that need to be addressed to inform their decision as to incorporate livestock grazing as a tool for coastal upland habitat management along the GoM coast. Those identified research questions shaped the objectives for the proposed project that includes the assessment of the 1) potential for livestock to spread and manage invasive and non-target species and 2) frequency and duration of livestock grazing needed to meet management goals across multiple habitat management scenarios. The timeline for this decision is driven by the proposed research and is targeted to be immediate upon demonstration of habitat benefits. To facilitate the co-production and immediate transfer of findings and products, a team of natural resource managers, extension specialists, researchers, and co-production specialists will engage with a broader group of natural resource managers throughout the project and adaptively steer the scope of work to ensure usability and applicability of products.

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1 A DESCRIPTION OF THE NATURAL RESOURCE MANAGEMENT DECISION

The natural resource management decision being addressed by the proposed scope of work is whether to use livestock for coastal upland habitat management in the US Gulf Coast states (ranging from western Texas to the panhandle of Florida). The extensive team of natural resource managers associated with the plan are ready and eager to immediately implement livestock grazing as a habitat management tool once research-based information is available to inform grazing planning and reduce uncertainties. The scope of work in this plan has been shaped over multiple years of discussions and needs assessments with the project team and other natural resource managers. A survey was developed as part of a currently funded NOAA RESTORE Science Program planning grant to assess the interest, need, research gaps, and logistical gaps associated with using livestock for coastal upland habitat management in the US Gulf Coast states (Gill et al. 2022). The survey was sent to natural resource managers, livestock producers, and researchers throughout the US Gulf Coast. Results from that survey and further discussions with those user groups, including the project team, directly led to the proposed scope of work.

Coastal upland habitat restoration and management is difficult due to the initial investment of resources, continued maintenance, specialized experience, equipment, and training required (Fleischner 1994; Gibble, Miller, and Harwell 2020). Some common habitat management techniques include applications of prescribed fire, herbicide, mulching, and other mechanical treatments. Each of these techniques is associated with different levels of cost-effectiveness, intrusiveness, and strategy (Launchbaugh 2006; Franklin, Johnson, and Johnson 2018). Another practice that has been highly successful in some areas of the United States is the use of livestock for habitat management and restoration (Harnett, Hickman, and Walter1996; Fuhlendorf et al. 2009; Oles et al. 2017). For example, pyric herbivory, the coupling of prescribed fire and accompanying grazing pressure, has been shown to create heterogeneity and diversity in vegetation communities and reduce occurrence of invasive species in grassland communities (Fuhlendorf et al 2009; Porensky et al. 2018). Similar effects of grazing have been observed in coniferous forests of the western United States. Livestock (e.g., sheep) have been used in open forest management strategies to increase habitat value (Thomas 1984; Ellen 1990; Sharrow 2006). While the potential benefits of incorporating livestock grazing into habitat management are evident, these practices require substantial knowledge of both animal husbandry, ecological health, and logistical considerations (Greiman 1988; Launchbaugh 2006). When implemented effectively, livestock grazing is considered to be one of the most cost-effective methods for habitat management because of the potential economic return from livestock gains.

There are many terms associated with these practices such as conservation, targeted, or prescribed grazing, but all essentially use livestock to simulate natural herbivory and/or complement other land management activities (Caudle and Daigle 2016). The geographic focus of most of these grazing efforts are in areas where large herds of native herbivores historically ranged, such as the midwestern and western United States (Harnett, Hickman, and Walter1996; Van Lear et al. 2005; Davies et al. 2022). However, large herds of grazers were historically present in other areas of the United States that rarely use livestock grazers for habitat management activities. One of these areas included the coastal uplands along the northern Gulf of Mexico (GoM) coast, where grazing played a large role in the creation, sustainability, and diversity of habitats in this area, along with wildfires and tropical systems (Caudle and Daigle 2016; Noss 2013). Grazing by large herbivores stimulated the development and maintenance of diverse and productive understory or prairies (Packard and Mutel 1997). The plant and animal communities in these coastal uplands were once shaped by a combination of grazing by bison (*Bison bison*) and other grazers and being burned by Native Americans as well as naturally occurring wildfires by lightning strike (Grace et al. 2005; Van Lear et al. 2005); thereby shaping the plant and animal communities in the area. Fire suppression, loss of naturally roaming megaherbivores except white-tailed deer (*Odocoileus virginianus*), and free-range laws in response to overpopulation and overgrazing of free-range cattle, led to the overgrowth of woody underbrush, thereby limiting understory production and quality, that is common in most of this area today (Caudle and Daigle 2016). As the concern for habitat degradation increases, efforts to restore and maintain coastal uplands are focusing on practices that reflect natural and historically prevalent processes.

The timing of prescribed burning (spring vs. summer), rest periods between fire and grazing, and how much grazing pressure can have a large impact on the recovery of plant communities (Bates et al. 2009). Though there are considerable benefits to annual burns, this practice is not always feasible in current conditions (Braasch et al. 2017). In addition to the cost and often limited effectiveness, prescribed fire is becoming more difficult to conduct due to encroaching development and unpredictability of weather windows (Hulme 2005). Climactic occurrences such as droughts, flooding, and high winds can prevent annual prescribed burn cycles. Additionally, prescribed burns carry risk to human habitation, liability concerns, and heavy costs that are compounded by increasing development along the US GoM coast (Van Lear et al. 2005). Having the option to graze in areas that are difficult to manage with other techniques could give land managers another tool that is less restricted by development, weather, and other environmental factors. Combined with a well-structured habitat management plan informed by locally relevant research, these land management techniques could replicate historic disturbances within coastal upland plant communities. In other areas of the United States, paired land management techniques (e.g., prescribed burning and grazing) have been used to maintain habitats.

Most research available on using livestock for habitat management has been conducted in areas with different environmental conditions and plant community assemblages than coastal upland habitats of the GoM. The lack of research limits the ability to apply grazing practices with research-based information in this area. Even within the northern GoM region, there are significant differences in habitat types, productivity, and habitat management goals that could impact the implementation or benefit of livestock grazing for habitat management. For example, the Mission-Aransas National Estuarine Research Reserve (NERR) is predominantly-interested in converting and restoring scrub-shrub communities back to coastal prairie habitats where diverse and productive grasslands once thrived (Diamond and Smeins 1984; Evans, Madden, and Palmer 2012). Conversely, the NERRs in Mississippi (Grand Bay), Alabama (Weeks Bay), and Florida (Apalachicola) are mostly interested in restoration and conservation of pine savannas (Peterson, Waggy, and Woodrey 2007) and flatwoods where lack of management has led to the displacement of diverse herbaceous understory with woody understory (Van Lear et al. 2005). Restoration goals in these habitats include understory thinning, removal of invasives, and restoration of native plants. While each of these ecosystems are unique and composed of varying ecological communities, anecdotal information from land managers across this region, predominantly private property owners, suggests that incorporating livestock into habitat management in these areas has the potential to be a cost-effective method to reach restoration and conservation goals (Gill et al. 2022). However, the lack of research available to in-

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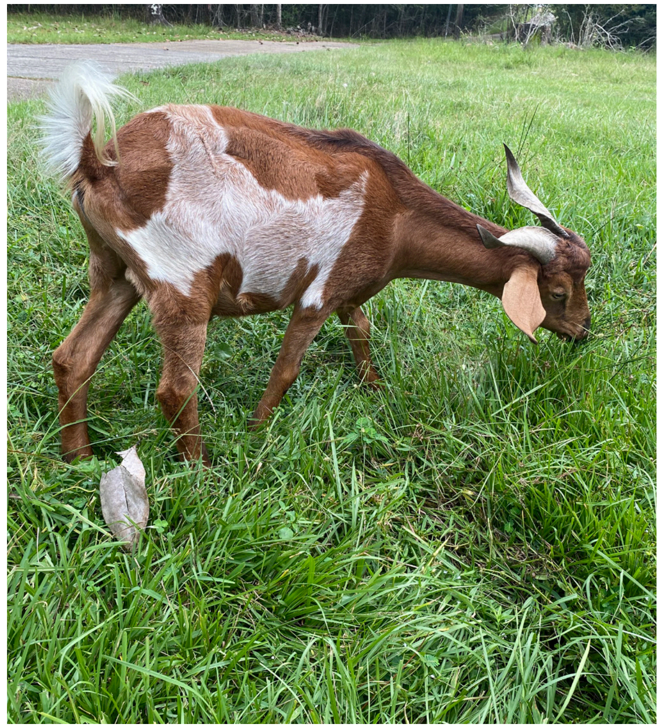

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form grazing plans is a barrier to using livestock for grazing on both public and private lands in this region.

As part of a currently funded NOAA RESTORE Science Program planning grant, this project team developed a survey to better understand the interest, management needs, research needs, logistical and environmental concerns associated with conservation grazing along the GoM coast (Gill et al. 2022). Survey results showed that over 96% of respondents (mostly natural resource managers) were interested in incorporating conservation grazing into their habitat management plans, but none were aware of any research-based information available that could help inform grazing plans. However, most thought that cattle and goats were the grazers with the most potential habitat benefits and easiest to handle logistically (Gill et al. 2022). Given the lack of research-based information, basic research questions were identified as the first to address from the survey and were corroborated by the natural resource managers on the project team. These included 1) what is the potential for grazers to transport invasive or non-target plant species? and 2) what is the frequency and duration of grazing needed to achieve habitat management goals? (Gill et al. 2022), and these will be addressed with the proposed scope of work.

In California grasslands, both invasive and native grasses and forbes were seen to be transferred by cattle by both epizoochory and endozoochory (Chuong et al. 2016). However, due to the high diversity of transported species, cattle were essential to native plant dispersal in California rangelands (Chuong et al. 2016). Goats have been shown to significantly reduce the viability of ingested seeds in most plants (Harrington, Beskow, and Hodgson 2011), but no assessments have been done for the plant species identified as critical by the natural resource managers on the project team.

While some concerns for spreading of seed in the area could be reduced with timing of grazing to not intersect with seeding times for local plants, it is not feasible to avoid all seeding periods. Further discussions with the natural resource managers and other resource users identified a range of management scenarios that should be addressed to immediately inform and help them make natural resource management decision about incorporation of conservation grazing into their plans. All of these scenarios (described in Section 2) involved initial clearing or maintenance of woody underbrush or invasive species, and goats are known to be very effective at these measures (Hart 2001; García et al. 2012). For the initial research on this topic (the proposed scope of work), the natural resource managers thought goats provided the most utility for addressing their immediate management needs; thus, they are the livestock species of interest for the proposed research.

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OBJECTIVES AND METHODS

The overall research objectives identified in this plan are to assess the 1) potential for livestock to spread and manage invasive and non-target species and 2) frequency and duration of livestock grazing needed to meet management goals. These broad objectives are meant to cover a wide range of scenarios and potential applications, as outlined through the scoping and design phase, of conservation grazing throughout the GoM states. To address these research objectives and answer associated research questions, the project team has developed both trial and field-based experiments that were directly co-produced by natural resource managers and other resource users. While the currently scoped research directly addresses uncertainties needed to inform conservation grazing along the GoM, the project team recognizes that research discovery often leads to new questions and objectives. To adaptively manage the project, feedback from quarterly project team and semi-annual resource user group (RUG) meetings (described in Section 5) will be used to adaptively steer the project toward addressing related research uncertainties as they arise; therefore, maximizing the potential for application of information and products generated from the proposed project. The remainder of this section will be focused on the proposed methods to address research uncertainties.

Objective 1 – Potential for livestock to spread and manage invasive and non-target species. A barrier to implementation of conservation grazing in the region is a limited understanding on the potential for livestock to spread invasive or non-target plant species. However, there is evidence that digestion process in goats has the potential to reduce propagation of most seeds (endozoochory; Harrington, Beskow, and Hodgson 2011). Another avenue for transport of plant seed is through external attachment of seeds (epizoochory). Both of these processes will be assessed in the proposed project.

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Endozoochory trials will be conducted in Year 1 of the project following methods adapted from Harrington, Beskow, and Hodgson 2011) but focused on invasive and non-target species identified by the project team. Invasive species of interest will include Chinese tallow (*Triadica sebifera*), Chinese privet (*Ligustrum sinense*), cogon grass (*Imperata cylindrica*), Brazilian pepper (*Schinus terebinthifolius*), and Guinea grass (*Megathyrsus maximus*). Native, but undesirable plant species for pine savanna and prairie restoration that will be assessed include southern wax myrtle (*Myrica cerifera*), gallberry (*Ilex glabra*), yaupon holly (*Ilex vomitoria*), honey mesquite (*Prosopis glandulosa*), and huisache (*Acacia farnesiana*). Prior to any trials, each of the 20 goats used in this study will be housed individually and fed a strict alfalfa (*Medicago sativa*) diet for 2 weeks. Each goat will be monitored to ensure habituation with the alfalfa diet while also allowing for any seed ingested in the field to pass. One thousand seeds from each of these 10 plant species will be collected, mixed with molasses, and fed (Harrington, Beskow, and Hodgson 2011) to each of the 20 goats used in these trials. Twenty additional sets of seed mix will not be fed to goats and used as controls for each step of the goat trials described below. A subset of the seed mix will also be assessed for seed length and germination potential using the guidelines in the International Rules for Seed Testing (ISTA 1996). The mass of seed ingested by each

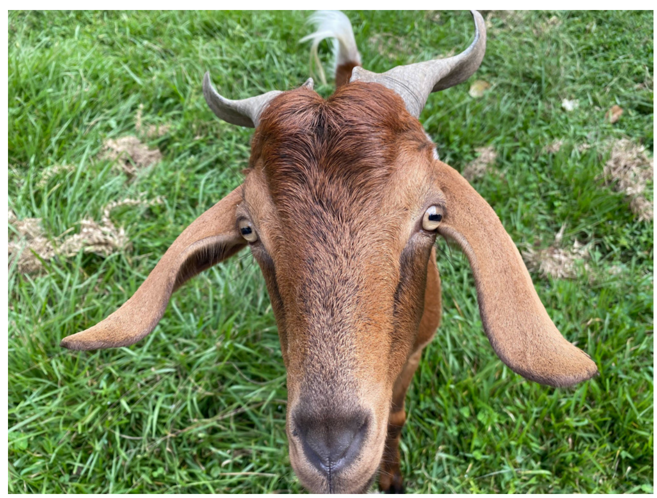

Photo credit: Eric Sparks/MSU Extension

goat should be less than 40 g, which is equivalent to approximately a handful. After seeds are confirmed to be ingested, the goats will resume their alfalfa diet during the monitoring period. All feces from each goat will be collected every 24 hours for a total of 6 days. This sampling timeline was chosen to align with the window of opportunity to collect seeds as they pass through the digestive track in 11-72 hours (Harrington, Beskow, and Hodgson 2011). Collected feces for each goat and each day will be subsampled with 25% of the total weight of feces being used for seed recovery and an additional 25% of weight used to determine if seed will germinate from intact feces. All feces collected for the seed recovery assessment will be soaked in water for 12 hours, washed through a 0.5 mm mesh strainer, and then searched for seed. Collected seed will be separated into plant species, counted, and assessed for viability/germination potential using the International Rules for Seed Testing guidelines (ISTA 1996). After all visible seeds are collected, the remaining feces (each goat per day) will be potted in sterile potting mix and placed in a greenhouse. Any seedlings that sprout from the potted feces will be counted and identified over a period of one year. The other 25% of feces (determined by weight) collected from each goat per day will be placed directly into sterile potting mix and observed weekly for one year to determine if seed will sprout directly from intact feces. Any seedlings that germinate will be counted and identified. As mentioned earlier, 20 sets of seed mix that was not fed to goats will also be subjected to the same testing described above (e.g., soaking, rinsing, planting, etc.) to serve as controls.

Epizoochory (transport of seed via fur) will be assessed using modifications to the methods described in Liehrmann et al. (2018). At least 30 seed or seedheads from each of the 10 plant species used in the endozoochory trials will be partially painted with fluorescent paint (to help track later) and manually attached to each of the 20 goats used in these trials. Goats with a range of fur lengths will be selected with a target of 10 short hair and 10 longer hair goats. Fur length on each target body zone (head, torso, and legs) for each goat will be measured before each trial. The 30 attached seed will cover these three distinct body zones with each having 10 of each plant type. The goats will then be allowed to graze in a fenced area with heavy understory and checked every 15 minutes for a period of 6 hours. During each check, the presence/absence of each placed seed will be recorded. Between checks, the behavior of each goat will be recorded (e.g., the number and timing of grooming, play, shaking, rolling, scratching, etc. sessions) as this could affect the dislodging of plant material. At the end of the 6-hour trial, each goat will also be combed and thoroughly inspected for additional seed that may have attached during the trial. Each found seed will be collected and measured with the body location recorded and identified.

Objective 2: Frequency and duration of livestock grazing needed to meet management goals. As mentioned previously in Section 1, despite overwhelming interest and potential benefits of conservation grazing identified by natural resource, there is limited research-based information available that can directly inform conservation grazing along the US Gulf Coast. One of the most pressing research needs identified throughout the scoping and design process of the proposed project is a basic understanding of the duration and frequency of conservation grazing needed to address natural resource management goals. However, natural resource managers have many different scenarios in which conservation grazing could be applied with more research, and those different scenarios are covered in the scope of work below.

One of these management scenarios is focused on the clearing and maintenance of woody underbrush. Research trials for this scenario will occur within the Fennessey Ranch (managed by the Mission-Aransas NERR) and the other at the Grand Bay NERR. It was determined by the project team that findings from the Grand Bay NERR trial can directly inform coastal upland management from Louisiana to Florida (e.g., Weeks Bay and Apalachicola NERRs), whereas the Fennessey Ranch trial can inform coastal prairie restoration and management efforts throughout Texas. At Fennessey Ranch, cattle are free-roaming and are likely overgrazing much of the herbaceous plants. However, the cattle have not adequately suppressed the woody understory to allow for re-establishment of coastal prairie. Therefore, this site will have a control (cattle grazing) plus two additional treatments levels (no grazing and goat grazing) that will be fenced. The Grand Bay NERR has areas that are overgrown with woody underbrush from a lack of prescribed fire or initial regrowth from alternative management methods, such as forest mulching. Related to this management scenario, the Grand Bay NERR site will have four separate treatment levels that include grazing (fenced with goats) and controls (fenced without goats and no fence) in both a woody underbrush overgrowth area (initial clearing) and an area that has been recently mulched (maintenance). An additional treatment level at each site will address grazing frequency and will include plots that are grazed once per year and four times per year. Each treatment combination will be replicated five times and have a plot size of 2,500 sq m (50 m x 50 m). This design leads to a total of 30 plots (3 grazing treatments x 2 grazing frequencies x 5 replicates) at Fennessey Ranch and 40 plots (4 grazing treatments x 2 grazing frequencies x 5 replicates) at the Grand Bay NERR for this management scenario.

Within each plot, three equally spaced vegetation transects will be established that stretch from the northern to southern edge of each plot (50 m). At the 10 m, 20 m, and 30 m points along these transects, a permanent 4 m^2 vegetation quadrat will be established, in which vegetation diversity and density will be assessed with visual counts and measurements using an iteration of the Carolina Vegetation Survey method (Peet, Wentworth, and White 1998). Near each transect point, sediment cores and porewater samples will be collected. These samples will be analyzed for compaction, grain size, bulk density, organic matter, and dissolved organic/inorganic nitrogen. Additionally, at each quadrat point, photos will be taken in each cardinal direction with

Photo cedit: Kevin Hudson/MSU Extension

a standard camera and a normalized difference vegetation index (NDVI) camera and used to estimate under- and mid-story coverage following photo processing methods adapted from Salas-Aguilar et al. (2017) and https://publiclab.org/wiki/ndvi. NDVI is widely used in forestry and agricultural settings to determine spatial coverage of live green vegetation (Xue and Su 2017) but will be used to estimate the impact of grazing on the prevalence of live green vegetation in the proposed project. Unmanned aircraft system (UAS)-based mapping and monitoring will also occur to estimate whole plot changes in vegetation density, height, and plant health. A UAS will be used to obtain high-resolution (i.e., <2 cm per pixel) imagery of the entire study area. This imagery will then be processed using DroneDeploy to produce orthomosaic maps of both the basic imagery, canopy height, and estimations of plant health (NDVI). The project team routinely conducts UAS monitoring and has all required certifications/permissions necessary to conduct the proposed flights. Finally, estimations of light penetration to the understory will also be assessed on each sampling day with deployment of a light sensor at 1 m above the sediment surface (pole mounted) in each plot and at a nearby open field. Each variable described above will be measured immediately before and after grazing periods for all plots and every other month between grazing periods.

All grazing plots at each site will be serviced by a local grazing contractor. These services include providing livestock at stocking densities and durations determined by the research team, providing water and supplementary feed for livestock (if needed) at field sites, documenting and reporting supplemental feed and water provided during experiments, rotation and removal of livestock, and fencing installation, rotating, and removal) associated with experiments. Prior to the start of experiments and unique to each location, stocking density and duration pilot trials will be conducted to determine the stocking density/duration combination necessary to reach the target grazing level as determined by the natural resource managers on the team. It is anticipated that goat grazing will be done with a high density (10-50 goats per plot) and short duration (2-7 days) for each grazing event.

The other management scenarios covered by the proposed project will be assessed using the same methods described above and include grazing of difficult to manage stands of environmentally sensitive (bird nesting area; Apalachicola NERR) and invasive species (cogon grass; Grand Bay NERR). The Apalachicola

Photo cedit: Keith Chenier/MSU Extension

NERR manages an island that is protected shorebird nesting habitat but find it difficult to manage for shorebirds due to continuous overgrowth of vegetation. The Grand Bay NERR (and many areas throughout the US Gulf Coast) struggle with management of aggressive invasives, such as cogon grass. Fire is relatively ineffective on cogon grass because it most often expands coverage post-burn. Outside of heavy chemical treatments that functionally sterilize soils, grazing may be an effective option to manage these types of areas. The extent of the areas to test both management scenarios is smaller than the woody underbrush scenario decribed earlier. Therefore, the size of these plots will be reduced to 20 m x 20 m (400 sq m), and monitoring will be scaled accordingly. Each site (Apalachicola and Grand Bay NERRs) will have areas that are grazed once per year and four times per year, in addition to five replicates of non-grazed controls. Additionally, nesting bird counts will be collected by Audubon Florida, and no grazing will be conducted during nesting season. For all trials and field sampling, ANOVA and regression techniques will be used to assess statistically significant treatment effects.

Photo cedit: Kevin Hudson/MSU Extension

3

A LIST OF EXPECTED PRODUCTS

The collective project team (including the resource user group - RUG) has developed the proposed scope of work to directly reduce or eliminate uncertainties related to the potential of livestock for habitat management of coastal uplands. Based on research-based information from other regions, observations during field visits with grazing practitioners, and input/discussions with natural resource managers, livestock producers, and other researchers (Gill et al. 2022), the project team expects livestock (specifically goats) to be a highly effective tool for addressing habitat management needs of coastal uplands. However, the management scenarios and grazing frequency/duration in which they will be more or less effective are less certain. The scope of work in the proposed project will undoubtedly lead to natural resource managers determing if goat grazing is appropriate for their coastal upland habitat management scenario. All natural resource managers engaged throughout the scoping and design phase of the proposed projeact are very eager to implement livestock grazing as they see it as potentially very beneficial. Expected products include at least three journal articles and extension/outreach products. The anticipated journal articles would focus on 1) the potential spread of invasive and non-target species by goats through gut passage of seeds and transport on fur, 2) the utility of livestock to manage undesirable vegetation and provide habitat benefits, and 3) an assessment of the co-production process used in the proposed project. The format and structure of the extension/outreach products would be adaptively driven by research findings and input during project and RUG team meetings. However, extension publications (print), field days, informational videos, development of a short course for natural resource managers, or other products are anticipated. All products (including research publications) and other pertinent information will be housed as open access on the Mississippi State University (MSU) Conservation Grazing website (https://coastal.msstate.edu/grazing).

Photo cedit: Chesapeake Bay Program

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A SCHEDULE WITH MILESTONES

Milestone	Task	Task Category	Task Start Date	Task Completion Date	2023			2024												2025												2026								
					Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4		
					O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Milestone 1: Project team and RUG meetings					-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
1.1	Create online data and communications hub (Google and/or Basecamp)	Internal comm	10/1/2023	11/30/2023																																				
1.2	Project team meetings	Meetings	11/1/2023	8/31/2026																																				
1.3	Recruit more resource advisory group participants	Meetings	10/1/2023	9/30/2026																																				
1.4	Resource advisory group meetings	Meetings	12/1/2023	6/30/2026																																				
Milestone 2: Personnel, subawards, and contracting					-	-	-	-	-	X	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
2.1	Advertise for hired personnel	Personnel	10/1/2023	10/31/2023																																				
2.2	Interview and hired personnel	Personnel	10/1/2023	11/30/2023																																				
2.3	Establish subawards	Contracting	10/1/2023	11/30/2023																																				
2.4	Develop and advertise for grazing contractors	Contracting	10/1/2023	1/1/2024																																				
2.5	Accept bids and select grazing contractors	Contracting	1/1/2024	3/31/2024																																				
Milestone 3: Potential for livestock to spread and manage invasive and non-target species trials					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	
3.1	Obtain IACUC approval	Research	10/1/2023	11/30/2023																																				
3.2	Epizoochory trials	Research	1/1/2024	2/28/2024																																				
3.3	Endozoochory trials	Research	3/1/2024	5/31/2024																																				
3.4	Post-endozoochory greenhouse trails	Research	4/1/2024	2/28/2025																																				
3.5	Analyze data	Data analyses	1/1/2024	8/31/2025																																				
3.6	Prepare data and metadata for long-term storage	Data management	1/1/2024	12/31/2025																																				
Milestone 4: Frequency and duration of livestock grazing needed to meet management goals trials					-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	X
3.1	Overgrazing pre-trials in representative areas to assess combination of frequency and duration needed for each subsequent grazing event	Research	6/1/2024	8/31/2024																																				
3.2	Establish plots and initial fencing	Research	6/1/2024	8/31/2024																																				
3.3	Introduce and remove grazers	Research	6/1/2024	7/30/2026																																				
3.4	Remove temporary fencing	Research	10/1/2024	7/30/2026																																				
3.5	Conduct pre-grazing and post-grazing monitoring	Research	5/1/2024	9/30/2026																																				
3.6	Analyze data	Data analyses	5/1/2024	9/30/2026																																				
3.7	Prepare data and metadata for long-term storage	Data management	5/1/2024	9/30/2026																																				
Milestone 5: Products					-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	X
3.1	Epizoochory and endozoochory publication	Publication	6/1/2024	12/31/2025																																				
3.2	Grazing frequency and duration publication draft	Publication	8/1/2025	9/30/2026																																				
3.3	Co-production process publication draft	Publication	12/1/2025	9/30/2026																																				
3.4	Extension and outreach products - discussions to adaptively determine format and content by RUG and project team	Outreach/Extension products	11/1/2023	8/31/2026																																				
3.5	Extension and outreach products (format and content determined by RUG and project team)	Outreach/Extension products	6/1/2025	9/30/2026																																				
Milestone 6: Assessment and Reporting					-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	X
3.1	Assessments of co-production process	Assessment	1/1/2024	6/30/2026																																				
3.2	Progress reports	Reporting	5/1/2024	9/30/2026																																				
3.3	Science Program checkins	Reporting	4/1/2024	4/30/2026																																				
3.4	Archive and upload data/metadata to MSU repository	Data management	1/1/2024	9/29/2026																																				
3.5	Final report	Reporting	5/1/2026	9/30/2026																																				

Photo cedit: USFS Southern Region

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A LIST OF THE RESOURCE MANAGERS, RESEARCHERS, AND OTHER STAKEHOLDERS INVOLVED AND THEIR ROLES AND RESPONSIBILITIES

Investigators, Institutions, E-mail Addresses, and Roles (L for lead investigator, CPL for co-production lead, CPS for Co-production specialist, NRM for natural resource manager, CI for co-investigator):

- Eric Sparks; Mississippi State University; eric.sparks@msstate.edu; Role: L, CPL
- Jonathan Pitchford; Grand Bay NERR; jonathan.pitchford@dmr.ms.gov; Role: NRM, CI
- Katie Swanson; Mission Aransas NERR; katie.swanson@utexas.edu; Role: NRM, CI
- Megan Lamb; Apalachicola NERR; megan.lamb@dep.state.fl.us; Role: NRM, CI
- Eric Brunden; Weeks Bay NERR; eric.brunden@dcnr.alabama.gov; Role: NRM, CI
- Jacob Goff; Grand Bay NERR; Jacob.goff@dmr.ms.gov; Role: NRM, CI
- Stacy Hines; Texas A&M AgriLife Extension; stacy.hines@ag.tamu.edu; Role: CI, CPS
- Timothy Schauwecker; Mississippi State University; tschauwecker@lalc.msstate.edu; Role: CI
- Margo Posten; Grand Bay NERR; margo.posten@dmr.ms.gov; Role: CI, CPS
- Joan Garland; Mission Aransas NERR; joan.garland@utexas.edu; Role: CI, CPS

We carefully constructed a core multi-disciplinary team comprised of a collaborative group of natural resource managers, extension specialists, researchers, and co-production specialists throughout the northern GoM. Notably, the Stewardship and Coastal Training Program Coordinators from the NERRs along the northern GoM are involved in this project. The Stewardship Coordinators are responsible for the natural resource management decisions within their NERR boundaries and help inform other natural resource management decisions with partner agencies within their regions. Stewardship Coordinators that serve as Co-PIs on this project include Jonathan Pitchford (Grand Bay NERR), Katie Swanson (Mission-Aransas NERR), Eric Brunden (Weeks Bay NERR), and Megan Lamb (Apalachicola NERR). Two additional natural resource managers from the Grand Bay NERR (Jacob Goff and Emmett Carstons) are also represented as named personnel on the project team. Each Stewardship Coordinator will be responsible for informing, facilitating, and assisting with research activities at their respective NERR and aiding with the transition of research and extension/outreach products with other natural resource managers in the region. Additionally, they and all other team members will contribute to project team wide outputs including reporting, contributing to publications, and attending project team meetings. A wide range of other natural resource managers that are interested in implementing conservation grazing once information barriers are addressed through the proposed research are also integral to the project and include representatives from the Alabama Department of Conservation and Natural Resources and Weeks Bay NERR (Scott Phipps), Audubon Florida (Caroline Stahala), International Crane Foundation (Carter Crouch), Fennessey Ranch (Steven Floyd), Coastal Bends and Bays Estuary Program (Jake Herring), GVC Farms (Greg Crochet), Mississippi Department of Marine Resources Coastal Preserves Program, Wildlife Mississippi (Robert Smith), Land Trust of the Mississippi Coastal Plain (Sara Guice and Nick Boyette), South Alabama Land Trust (Connie Whitaker), Texas A&M AgriLife Extension (Bobby McCool), Mississippi Agricultural and Forestry Experiment Stations (Jamie Larson), Florida Department of Environmental Protection (Caitlyn Snyder), private landowners (such as Jim Currie), and more). These representatives from the stakeholder community (resource users) will assist the project team in scoping and adaptively steering to project and so that results and products are as applicable as possible through serving on the RUG and associated meetings. The Coastal Training Program Coordinators represented as Co-PIs on the project team include Margo Posten (Grand Bay NERR) and Joan Garland (Mission-Aransas NERR) and they will both serve as co-production specialists for this project. Stacy Hines from Texas A&M AgriLife Extension also has extensive experience with co-production and will serve as a co-production specialist on this project in addition to her research duties. They will be responsible for recruiting other resource users and working with the co-production lead (Eric Sparks) to run resource user advisory meetings and transitioning research into application. The primary research teams will be split between Texas A&M AgriLife Extension (Texas sites) and MSU (Mississippi and Florida sites). The Texas research team will be led by Stacy Hines who is a Rangeland

Habitat Management Specialist and Assistant Extension Professor. Her specific research focus at Texas A&M is varied interconnection between rangelands, the native, improved and invasive plant species in them, and the livestock and wildlife they support. She will be assisted in all of her activities by an Extension Associate supported by the proposed project. The MSU team will be led by Eric Sparks (PI) and Timothy Schauwecker with the assistance of a Senior Extension Associate/Postdoc and an additional Extension Associate. Both Eric Sparks and Timothy Schauwecker are professors at MSU and will serve as the primary research contacts for the entire project and specifically for the Mississippi and Florida sites. Sparks serves as the Director of Coastal and Marine Extension at MSU and Assistant Director for Outreach for the Mississippi-Alabama Sea Grant Consortium. His research and extension areas of interest are broad, but primarily focus on improving the cost-effectiveness of habitat management through collaborative research and exten-sion activities. Likewise, Schauwecker's research efforts focus on evaluating habitat management techniques and developing strategies for implementation. Sparks is also an experienced hobby goat farmer and is very familiar with the needs of livestock and their potential capacity for habitat management.

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BUDGET

The total federal funding request is $1,597,606: Year 1 - $547,498; Year 2 - $514,200; Year 3 - $535,908.

Photo cedit: USFS Midwest Region

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