EXAMPLE AIM Monitoring Design Worksheet
Updated: November 2017

Step 1: Develop management objectives; select additional ecosystem attributes and indicators to monitor

Step 1a: Monitoring Objectives or Goals

Field office management goals are presented in the State Land Health Standards (LHS), Resource Management Plan (RMP), the Sage Grouse RMP Amendment. All highlight the importance of healthy ecosystems, including vegetation, soil, water, and wildlife. In addition, RMP goals highlight the importance of monitoring for improving understanding of ecosystem functioning and carrying out adaptive management.

The following represents a synthesis of ecosystem management goals from the LHS, RMP, and Sage Grouse RMP Amendment:

- *"Upland" soils exhibit infiltration and permeability rates appropriate for the soil type, climate, landform, and geologic processes. Adequate soil infiltration and permeability allows for the accumulation of soil moisture necessary for optimal plant growth and vigor and minimizes surface runoff. (LHS#1; RMP)*
- *Riparian systems function properly and have the ability to recover from major disturbance such as fire, severe grazing, or 100-year floods. Riparian vegetation captures sediment and provides forage, habitat, and biodiversity. Water quality is improved or maintained. Stable soils store and release water slowly. (LHS#2; RMP; Sage Grouse Plan Amendment)*
- *Healthy, productive plant and animal communities of native and other desirable species are maintained at viable population levels commensurate with the species and the habitat's potential. Plants and animals at both the community and population level are productive, resilient, diverse, vigorous, and able to reproduce and sustain natural fluctuations and ecological processes. (LHS#3; RMP)*
    - *Emphasis on sagebrush biome (RMP; LHS#4; Sage Grouse Plan Amendment)*
- *Special status, threatened, and endangered species (federal and State), and other plants and animals officially designated by the Bureau of Land Management (BLM) and their habitats are maintained or enhanced by sustaining healthy, native plant and animal communities. (LHS#4)*
    - *Emphasis on greater sage grouse (RMP; Sage Grouse Plan Amendment)*
- *The water quality of streams and rivers located on or influenced by BLM lands will achieve or exceed state water quality standards. Water quality standards include the designated beneficial uses, numeric criteria, narrative criteria, and anti-degradation requirements set forth under State law as found in Rule 317-2 in the Utah Administrative Law, and as required by Section 303(c) of the Clean Water Act. (LHS#5; RMP)*

Step 1b: Select additional ecosystem attributes and indicators to monitor

Information about populations of threatened and endangered species is also necessary but should be gained through partnership with the state wildlife agency.

The BLM AIM terrestrial and aquatic core indicators (TN440; TR 1735-1, TR 1735-2) are relevant to all of the above objectives (e.g., Terrestrial and Aquatic Indicator Tables). At terrestrial plots, we will also monitor sagebrush shape, distance to the nearest sagebrush patch, and the distance to Pinon-Juniper trees or other tall structures to meet the requirements of the Sage Grouse Habitat Assessment

Framework (HAF). <u>E. coli</u> samples will also be collected from stream reaches that are heavily impacted by cattle grazing or that are immediately downstream of urban areas.

Example Terrestrial Indicators Table*. Identify which indicators will be monitored as part of this effort and where the associated data will be collected. For monitoring efforts that seek to evaluate RMP/LUP effectiveness, all BLM AIM core terrestrial indicator data should be collected in all locations, but contingent and supplemental indicators may be collected at a sub-set of monitoring locations. Specify which contingent and supplemental indicators you will monitor and describe the types of monitoring locations at which you will collect these data. Record the monitoring locations where contingent indicators should be denoted in the Core and Contingent column. Supplemental indicators should be written into their own row and the locations where these data will be collected should be recorded in the Supplemental column.*

Land Health Fundamental or Management Goal	***Indicators***	***Core + Contingent***	***Supplemental***
Watershed Function	*Bare ground*	*All locations*	
	Vegetation composition	*All locations*	
	Proportion of plotin large, intercanopy gaps	*All locations*	
	Soil aggregate stability	*All locations*	
	Write in supplemental indicator(s), if needed		
Ecological processes	*Bare ground*	*All locations*	
	Vegetation composition	*All locations*	
	Non-native invasive species	*All locations*	
	Proportion of plot in large, intercanopy gaps	*All locations*	
	Soil aggregate stability	*All locations*	
	Write in supplemental indicator (s), if needed		*NA*
Habitat Quality	*Bare ground*	*All locations*	
	Vegetation composition	*All locations*	
	Non-native invasive species	*All locations*	
	Plant species of management concern	*All locations*	
	Vegetation height	*All locations*	
	Proportion of site in large, intercanopy gaps	*All locations*	
	Sagebrush shape, distance to sagebrush patch, distance to Pinon-Juniper trees or other tall structures		*All locations*

Plot characterization or covariates	*Topography, Landscape unit and position, Soil profile*	*All locations*	

***Aquatic Indicators Table**. Identify which indicators will be monitored as part of this effort and where the associated data will be collected. For monitoring efforts that seek to evaluate RMP/LUP effectiveness, all BLM AIM-NAMF core aquatic indicator data should be collected in all locations, but contingent and supplemental indicators may be collected at a sub-set of monitoring locations. Specify which contingent and supplemental indicators you will monitor and describe the types of monitoring locations at which will you collect these data. Record the monitoring locations where contingent indicators should be denoted in the Core and Contingent column. Supplemental indicators should be written into their own row and the locations where these data will be collected should be recorded in the Supplemental column.*

Land Health Fundamental	***Indicator***	***Core and Contingent***	***Supplemental***
Water quality	*Acidity*	*All Locations*	
	Salinity/Specific Conductance	*All Locations*	
	Temperature (instantaneous)	*All Locations*	
	TN & TP	*All locations*	
	Turbidity	*NA*	
	Supplemental: E. coli		*Locations heavily impacted by grazing*
Watershed function and instream habitat quality	*Residual pool depth, length and frequency*	*All locations*	
	Streambed particle sizes	*All locations*	
	Bank stability and cover	*All locations*	
	Floodplain connectivity	*All locations*	
	Large woody debris	*All locations*	
	Ocular estimates of instream habitat complexity	*NA*	
	Thalweg depth profile	*NA*	
	Bank angle	*Locations heavily impacted by grazing*	
	Write in supplemental indicator(s), if needed		*NA*
Biodiversity / riparian habitat quality	*Macroinvertebrate biological integrity*	*All locations*	

	Ocular est. of riparian vegetative cover and structure	*All locations*	
	Canopy cover	*All locations*	
	Quantitative est. of riparian vegetative cover, composition and structure	*NA*	
	Write in supplemental indicator(s), if needed	*NA*	
Covariate or reach characterization	*Bankfull width, flood-prone width, human influence, photos, and slope*	*All locations*	

Step 2: Set the study area and reporting units; develop monitoring objectives.

Step 2a: Set the study area and reporting units

The study area for both aquatics and terrestrial monitoring efforts is all BLM lands and perennial streams and rivers within the West Desert District boundary (Figure 1). The target population for terrestrial monitoring includes accessible BLM terrestrial ecosystems as defined by the national Surface Management Agency layer and verified in the field. The target population for aquatic ecosystems includes streams and rivers defined as perennial by the medium resolution NHD that are verified in the field to have water at a minimum of 5 transects. Reporting units for this monitoring effort tie back to the monitoring objectives and include: the Field Office areas and sage grouse habitat areas (PHMA and GHMA). If designs stratified simply by field office do not produce enough sample points to report on sage grouse habitat, we may intensify monitoring efforts in those areas.

The geospatial data layers used to define the study area and reporting units were derived from the BLM's AIM Master Sample for terrestrial and aquatic systems and included:

- *BLM field office boundaries*
- *BLM land ownership: Surface Management Agency (SMA) layer published July 2015*
- *Sage Grouse Habitat Info: PHMA, GHMA, Focal Areas and Population Areas*
- *National Hydrography Dataset (NHD): medium resolution version 2.0*

Step 2b: develop monitoring objectives

Monitoring objectives were identified by adding quantitative benchmarks associated with the terrestrial and aquatic indicators that are related to each management goal (i.e. Terrestrial and Aquatic Indicator Tables). These benchmarks communicate the indicator values that must be achieved across a specific percentage of the landscape/resource to show that conditions are acceptable (meeting objectives) vs. unacceptable (not meeting objectives). For example, the first monitoring objective in table shows that soil aggregate stability should be greater than 4 across 70% of the landscape in order for the management goal to be achieved. Unacceptable conditions could trigger a change in management. Benchmark values were gleaned from policy, research, and professional judgment.

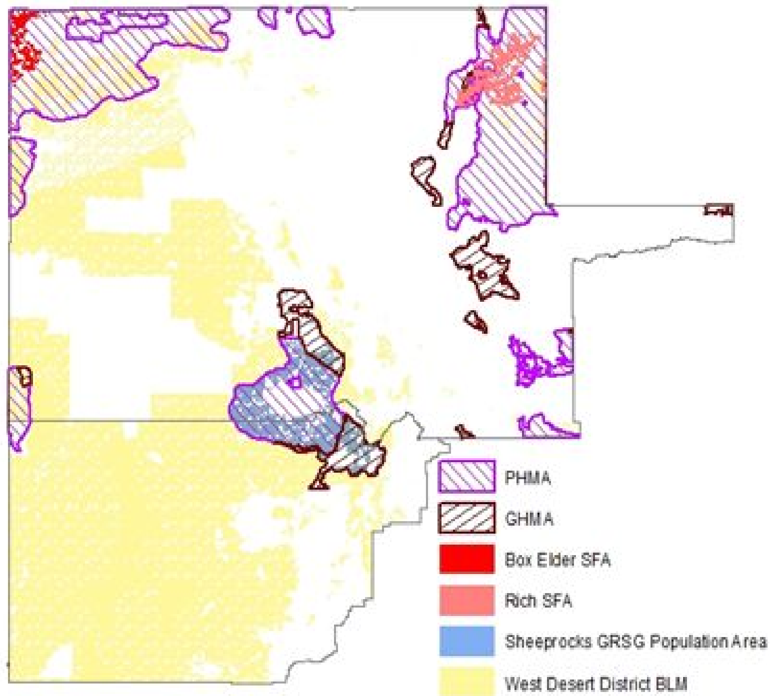

Figure 1. Terrestrial study area and reporting units for the AIM monitoring design in the West Desert District, Utah.

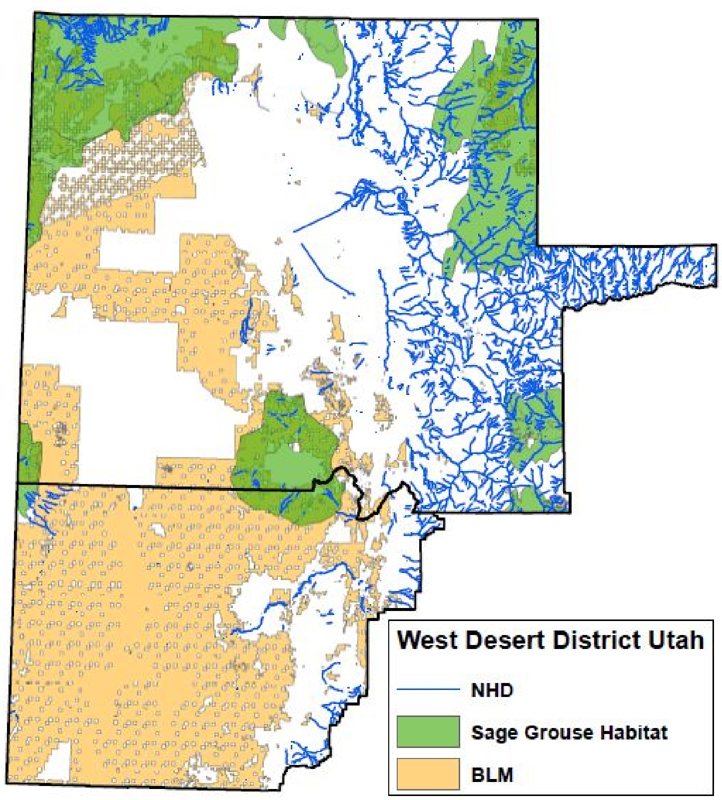

Fig 2. Aquatic study area and reporting units for the AIM monitoring design in the West Desert District, Utah.

Monitoring Objectives Table. Management objectives, indicators, and the methods to be used evaluating the attainment of management objectives for the study area. Assessing the attainment of management objectives requires a statement of the desired condition per indicator (i.e., condition threshold), as well as the amount or proportion of the resource that should achieve desired conditions. If objectives are not met, management actions are needed to address resource issues.

Management Goals (summarized from above)	**Monitoring Indicators**	**Condition determination method and source**	**Benchmark**	**Percentage achieving desired conditions (% of acres or stream km)[1]**	**Time Frame**
Soils (LHS#1; RMP)	*Soil Aggregate Stability*	*Research (Smith et al. 1999)*	*>=4*	*>70%*	*5 years*
	Bare Ground	*Professional Judgment, T. Henderson*	*Loamy soils: <=30%; Clayey soils: <=40%*	*>80%*	*5 years*
Healthy productive plant and animal communities (LHS#3; RMP)	*Plant Cover*	*Ecological Site Descriptions*	*Loamy soils: >=50%; Clayey soils: >=40%*	*>90%*	*5 years*
	Plant Species Richness	*Professional Judgment*	*>=15 sp per point*	*>90%*	*5 years*
	Macroinvertebrate biological integrity	*See below in water quality*			*5 years*
Special status, threatened and endangered species (RMP; LHS#3; Sage grouse plan amendment)	*Perennial Grass + Forb Cover*	*Research (see citations in Greater Sage Grouse RMP Amendment and EIS, Table 2.3, Page 2-29)*	*>15% **	*More than 80% of each habitat type should achieve conditions specific to that type **	*5 years*
	Sagebrush Height		*12 to 32 in **		
	Proximity of sagebrush to sage-grouse leks[2]		*Protective sagebrush cover occurs within 328 feet of lek*		
	Proximity of trees/other tall structures to sage-grouse leks[2]		*Trees/other tall structures are none/ uncommon within 1.86 mi of lek*		
	Predominant Sagebrush Shape[2]		*Greater than 50% in spreading*		

Riparian areas and stream channel morphology (LHS#2)	*Riparian vegetative complexity*	*Percentiles of regional reference conditions; USEPA*	*Minimal: > 30th percentile; Moderate: 30-10th percentile*	*> 80%; in non-sage grouse areas > 90% in sage grouse areas*	*5 years*
	Canopy cover	*Percentiles of regional reference conditions; USEPA*	*Minimal: > 30th percentile; moderate: 30-10th percentile*	*> 80%*	*5 years*
	Bank stability	*Professional judgement*	*Minimal: > 80% of banks are stable Moderate: 80% - 70% of banks are stable*	*> 80%*	*5 years*
	Percent fine sediment	*Percentiles of regional reference conditions; USEPA*	*Minimal: <70th percentile; Moderate: 70 - 90th percentile*	*> 80%*	*5 years*
	Floodplain Connectivity	*Percentiles of regional reference conditions; USEPA*	*Minimal: < 90% percentile; Moderate: 70-90th percentile*	*> 80%*	*10 years*
Water quality (LHS#5)	*Macroinvertebrate biological integrity*	*multi-metric index (MMI)*	*Mountains: < 42 Transition: < 42 Plains & Xeric: < 22*	*> 80%*	*5 years*
	pH	*UTDWQ numeric criteria*	*6.5-9*	*> 90%*	*5 years*
	Specific conductance	*Predicted Natural Conditions (Olson and Hawkins 2012)*	*Predicted natural values +/- 53.7 µs*	*>80%*	*5 years*

	E. coli	*UTDWQ numeric criteria[3]*	*1c: 668/100ml 2A: 409/100ml 2B: 668/100ml*	*> 90% of points surveyed*	*5 years*
[1]Different management areas (e.g., grazing allotment, PHMA, wilderness study area) are likely to have different management goals and thus benchmarks and/or the required proportion achieving those benchmarks.					
[2]Supplemental indicator					
[3]Utah Division of Water Quality Standards. Beneficial use categories 1C, 2A, and 2B are: drinking water, frequent primary contact recreation, and infrequent primary recreation respectively.					

Step 3: Select criteria for stratifying the study area (if necessary)

The geospatial data layers used to define strata were derived from the BLM's AIM Master Sample for terrestrial and aquatic systems and included:

- *Field Office boundaries*
- *Terrestrial: LANDFIRE Biophysical Settings (BpS)*
- *Streams/rivers: Strahler stream order categories from the NHD+, medium resolution version 2.0*

***Terrestrial -** The terrestrial landscape of interest is variable, ranging from blackbrush plains to 10,000-foot mountain peaks. Terrestrial monitoring will utilize LANDFIRE Biophysical Settings (BpS) as strata to distribute sampling effort across the landscape (Figure 3), but not for reporting purposes.*

***Aquatic -** The streams and rivers within the study area will be stratified by three Strahler Stream Order categories (Figure 4): small streams (1st and 2nd order), large streams (3rd and 4th order), and rivers (5th order and above).*

Step 4: Select and document supplemental monitoring methods; estimate sample sizes; set sampling frequency; develop implementation rules

Step 4a: Select and document supplemental monitoring methods (if required)

***Terrestrial -** The core terrestrial indicators are sufficient for evaluating most of the terrestrial management goals and monitoring objectives, as discussed in Steps 1 and 2. However, several supplemental indicators were identified that are not addressed by the core methods: sagebrush shape, distance to nearest sagebrush patch and distance to nearest juniper/tall structure. These supplemental indicators inform sage grouse habitat questions as part of the Sage Grouse Habitat Assessment Framework (Stiver et al. 2015). Distances to nearest sagebrush patch and distance to nearest juniper/tall structure can be measured using GIS with zero to minimal additional field time, especially with the help of good notes taken by the field crew (Stiver et al. 2015). The Field Office GIS staff will capture this information in an Excel spreadsheet following the field season. A standard method for describing sagebrush shape, consistent with the HAF is available in the National Resource Inventory (NRI) protocol (National Resources Inventory 2016). This information will be recorded every time a sagebrush plant is hit while doing Line Point Intercept, and electronically captured using DIMA. Supplemental training for* *field crews and field office staff will be made available to ensure that these methods are implemented successfully.*

Aquatic - *The aquatic core indicators will be sufficient for evaluating most of the aquatic management goals and monitoring objectives. However, the Utah Standards of Rangeland Health require that the BLM assess whether streams are meeting State water quality standards for* <u>*e. coli*</u>*. Since* <u>*e. coli*</u> *exceedances are only likely to occur in streams that are impacted by grazing,* <u>*e. coli*</u> *samples will only be collected at streams that are heavily used by cattle.* <u>*E. coli*</u> *samples will be submitted to the Utah Department of Environmental Quality, Division of Water Resources for analysis. The Aquatic Ecologist in the West Desert District will train the field crew on* <u>*e. coli*</u> *sample collection methods.*

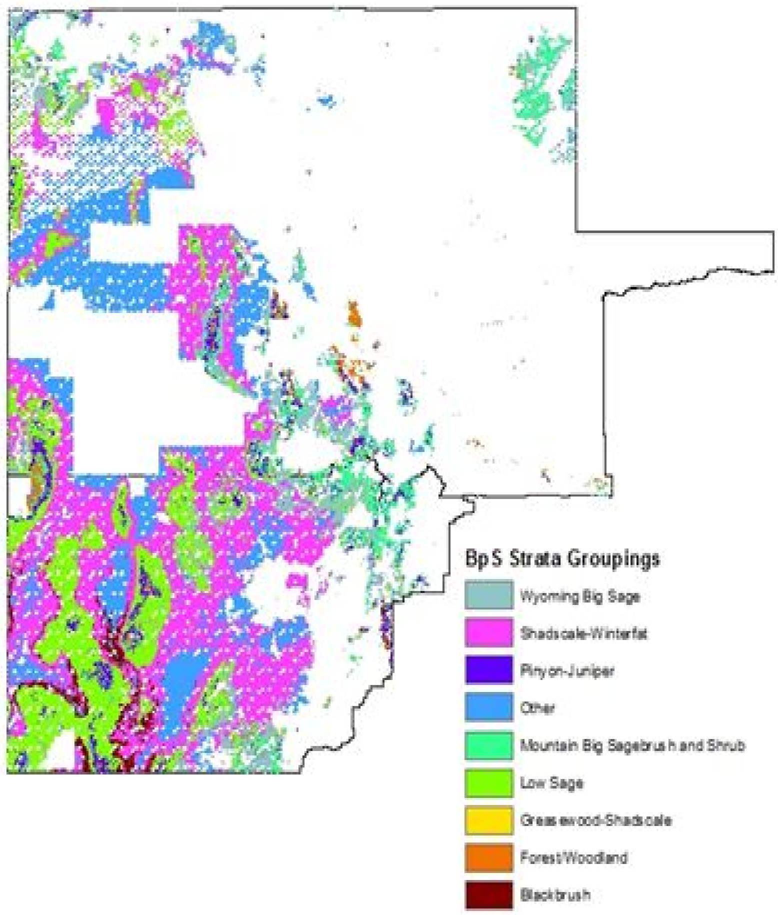

Figure 3. BpS Strata Groupings for the West Desert District terrestrial AIM monitoring design.

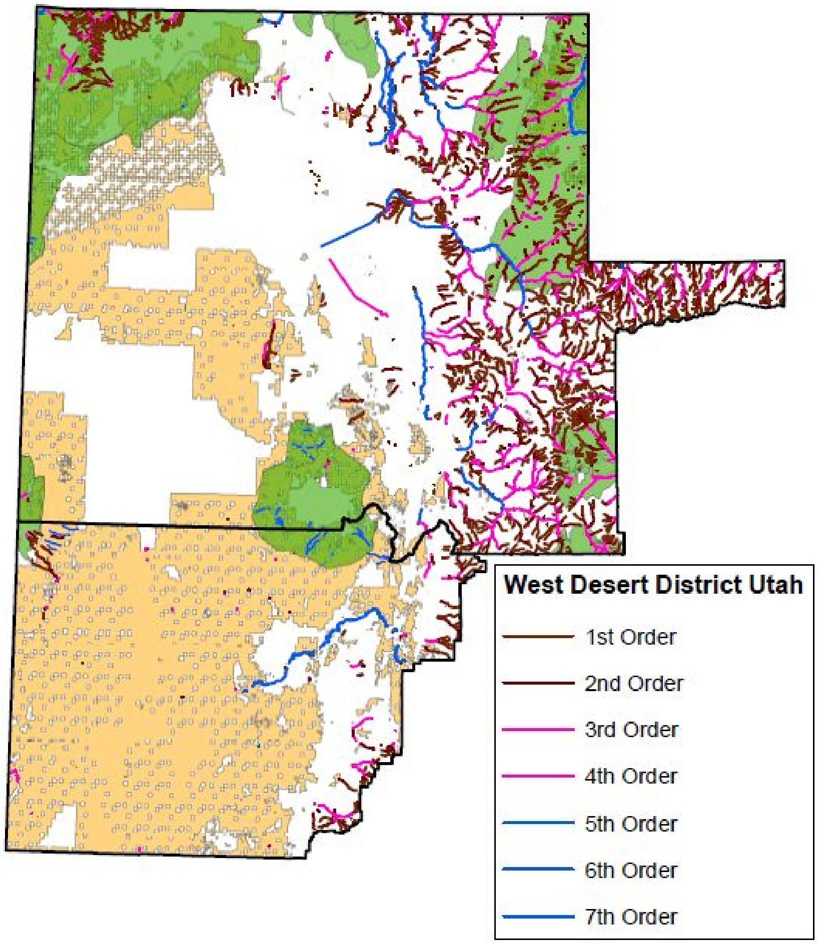

Figure 4. Strahler stream order categories for the West Desert District aquatic AIM monitoring design. First and second order streams are grouped into the "small stream" category, third and fourth order streams are grouped into the "large stream" category, and fifth order streams and above are grouped into the "river" category.

Step 4b: Estimate sample sizes

Terrestrial - *Sample sizes were determined for each stratum based on field crew capacity and the final proportion of acres represented by each stratum (Sample Design Table).*

Sample points per BpS unit will be proportional to BpS area on the landscape except where monitoring objectives suggest alteration (Figure 3; Sample Design Table; see Steps 4 and 5). Within the broader District, a decision was made to intensify monitoring within sagebrush-dominated strata (mountain big sagebrush and Wyoming big sagebrush) to address sage grouse habitat management objectives. Sampling intensity was reduced in the Shadscale-Winterfat strata.

Aquatic - *To balance personnel capacity, statistical power, budget etc., we worked with NAMC/NOC to select a sample size of 50 stream reaches for the district. We anticipate that a sample size of 50 will allow us to estimate the proportion of stream km in a given condition category with 80% confidence. Supplemental points can be added to increase the precision and accuracy of estimates as needed.*

There were no river km on BLM managed lands in the West Desert District, therefore we will only monitor small and large streams. Proportional allocation of points to small and large streams would have resulted in fewer than 10 points on large streams which seemed like an insufficient sample size, so we increased the point allocations in the large stream category to obtain a larger sample size and decreased the number of points allocated to small streams to keep the total number of sample points to the desired number of 50 points for the district.

Sample Design Table (terrestrial)*. Summary of LANDFIRE biophysical setting groups (strata) and associated point sample sizes used in the terrestrial sample design. The number of points per strata was determined by management priorities in the District, with a minimum sample size of 5 points per strata per year; individual sample points represent between 4,000 and 25,000 acres over the 5 year sampling period.*

Strata - Groups of LANDFIRE Biophysical Setting Groups	***Approx. stratum acres***	***Proportional area***	***Proportional points per stratum***	***Final points per stratum***	***Approx. point weights in acres***
Wyoming Big Sage	*821,000*	*0.11*	*0.14*	*75*	*11,000*
Shadscale-Winterfat	*2,519,000*	*0.33*	*0.22*	*117*	*21,600*
Pinyon Juniper	*293,000*	*0.04*	*0.07*	*36*	*8,200*
Other	*1,243,000*	*0.16*	*0.09*	*50*	*24,700*
Mountain Big Sagebrush and Shrub	*438,000*	*0.06*	*0.14*	*75*	*5,841*
Low Sage	*1,465,000*	*0.19*	*0.15*	*78*	*18,700*
Greasewood-Shadscale	*498,000*	*0.07*	*0.08*	*43*	*11,550*
Forest/Woodland	*118,500*	*0.02*	*0.05*	*29*	*4,043*
Blackbrush	*172,000*	*0.02*	*0.06*	*31*	*5,500*
Total	***7,700,000***	***1.00***	***1.00***	***532***	***NA***

Sample Design Table (aquatic)*. Summary of Strahler stream order categories (strata) and associated sample sizes used in the aquatic sample design. The number of points per strata is proportionate to the available stream kilometers, with a minimum sample size of three per strata; individual sample points represent between 19 and 23 stream kilometers.*

Strata - Strahler Stream order categories	***Approx. Stream km***	***Proportional length***	***Proportional points per stratum***	***Final points per stratum***	***Approx. point weights in km***
Small streams (1st and 2nd order)	*212.2*	*0.82*	*41*	*37*	*5.7*

Large streams (3rd and 4th order)	*45.2*	*0.18*	*8*	*11*	*4.1*
Rivers (5th+)	*0*	*0*	*0*	*0*	*0*
Total	***257.4***	***1.00***	***49***	***50***	***NA***

Step 4c: Set sampling frequency

Terrestrial - *One field crew can collect approximately 50 points in a monitoring season, so we intend to sample 100 plots per field season, for 5 years. Thus we are planning to hire and run two three-person field crews to collect terrestrial monitoring data for each of the 5 years.*

After the initial 5 year effort is complete. We plan to revisit 75% of terrestrial points on a five-year rotating basis in order to estimate trend.

Aquatic - *In our area, one aquatic field crew can collect data at approximately 25-30 reaches in a year. Thus to accomplish the desired sample size of 50 points, we plan to hire one, 2-person crew for the next two years.*

The objectives for trend monitoring will be determined after baseline conditions are established. Specifically, follow up monitoring will be focused on any indicators that raise red flags. The temporal scale that we will use to implement subsequent monitoring will depend on which indicators need to be monitored and the temporal scale that we expect them to change in response to natural environmental variability and/or management actions. For example, recommendations might be to assess water quality indicators on a monthly basis if exceedances are observed. In contrast, bank stability would be assessed on an annual or semi-annual time-scale.

Step 4d: Develop implementation rules

Terrestrial and Aquatic - *We will use the standard AIM implementation rules, the Terrestrial Plot Tracking Tool, and the Aquatic Design Management Spreadsheet to implement the designs and to document the fate of all design points (see aim.landscapetoolbox.org).*

Additional implementation rules are that the supplemental indicators will be collected at each terrestrial plot (see step 7).

Step 5: Collect and evaluate available data to determine sampling sufficiency and the validity of the strata (if available)

Terrestrial - *Terrestrial sample sufficiency analysis focused on the proportion of the area meeting a benchmark based on pre-existing data. Pilot data were available from an adjacent field office that has similar ecosystems and environmental characteristics. We looked at five different indicators: bare soil, total foliar cover, shrub cover, perennial grass cover, and perennial forb cover. In general, at most 27 samples were sufficient to estimate the proportion of the area meeting objectives for all indicators with 80% confidence and 10% margin of error. In cases where the observed proportion of the landscape meeting objectives was far away from the required proportion, fewer samples were required. Thus, the current design is sufficient to report out in any given year at the District or Field Office scale and over 5 years in the Sheeprocks Sage Grouse Population Area at these error levels. Reporting in the Rich and*

Box Elder SFA's, which have smaller sample sizes in this design, will result in a higher margin of error (e.g., 15% or 20%).

Aquatic *- No pilot data were available so we were not able to incorporate any previously collected data into our sample sufficiency analysis and strata validity.*

With the help of the NOC, we determined that our initial approach should be to collect data at 25 points and then do a sample sufficiency analysis to determine if our target sample size of 50 stream reaches will be enough to characterize conditions with enough confidence. We based this number on the worst case scenario of observing the maximum allowable variance for estimating a proportion (50%), with a 90% confidence level. This scenario will only allow one to detect degraded stream conditions when 50% (± 15%) of streams are in most degraded condition - an unacceptable amount from a management perspective. The actual variance observed at these initial 30 sample points will be used to determine the final sample size of this monitoring effort.

Step 6: Apply stratification and select statistically valid monitoring locations

Terrestrial - *Monitoring locations were selected by the Jornada using the terrestrial master sample tool (Figure 4). This tool relies on the GRTS method which produces random, spatially balanced points across the landscape of interest (Stevens and Olsen 2004). The ID team reviewed the points to make sure that they met the design criteria described in steps 1-3. During that review, the interdisciplinary team noted that in Year 1, more points were needed to report on sage grouse habitat conditions in the Box Elder SFA and the Sheeprocks GRSG Population areas in order to satisfy immediate reporting needs. Points were "borrowed" from later years of the design (Years 2-5) in order to provide additional points to be sampled the first year (Figure 5). The design was finalized on March 22, 2016 and is stored on the local field office share point drive.*

Aquatic - *In total 50 sample reaches were selected for potential sampling (i.e., base reaches) and over double that number as were selected as replacement reaches for failed reaches (i.e., oversample reaches = 100). All 50 sample reaches were selected for the RMP effectiveness monitoring design by the NOC using the aquatic master sample tool. However, due to errors in the NHD layer the draft design revealed that no points had been generated in the Sheeprock Sage Grouse area. Therefore, 10 additional reaches (and 30 oversample or replacement reaches) were selected to intensify the sample design in the Sheeprock Sage Grouse Habitat Area using an R script.*

The design was finalized on April 10, 2016. More information can be found in the aquatic design metadata file that is stored with the other design files on the local field office share point drive.

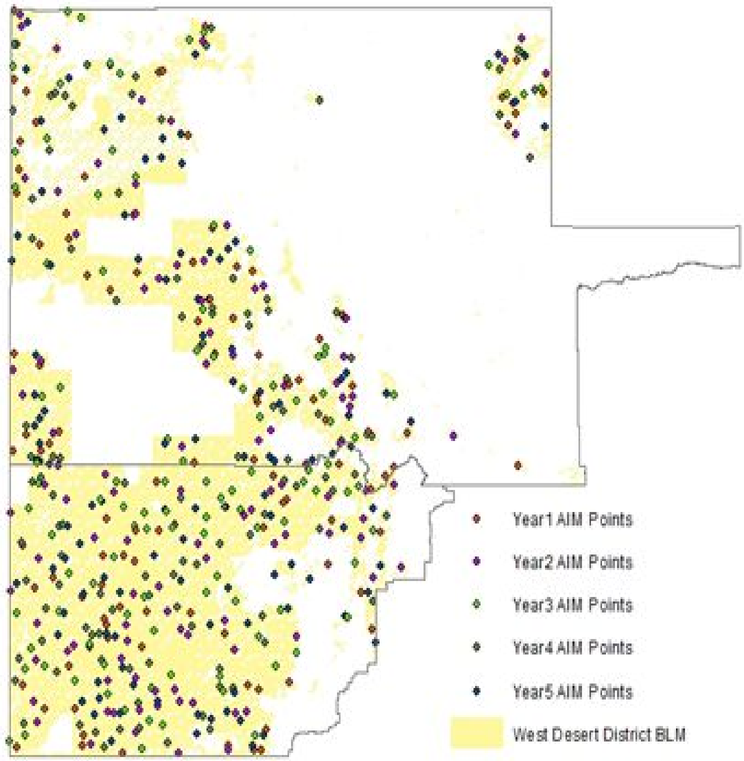

Figure 5. Final terrestrial sample design for the BLM district to address management and monitoring objectives.

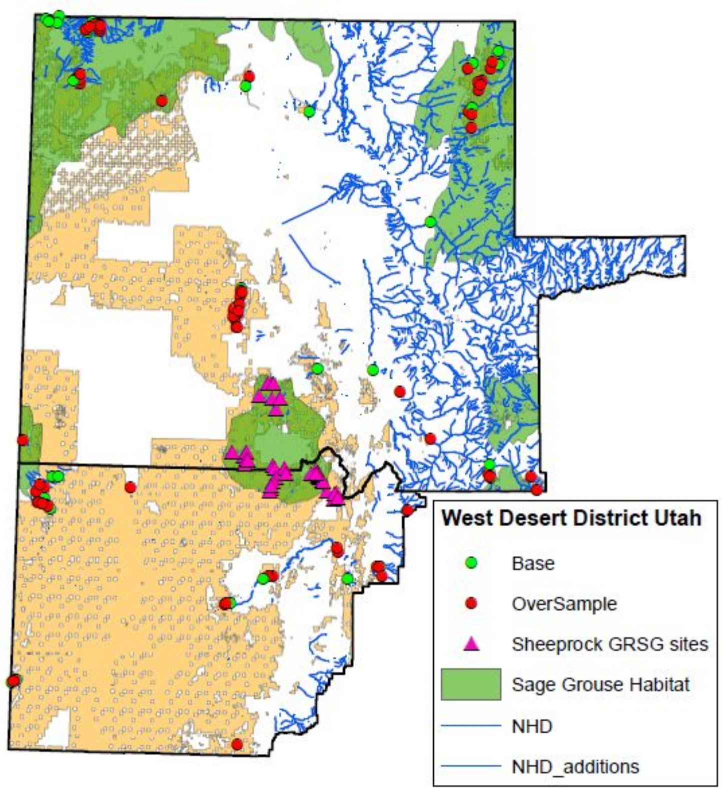

Figure 6. Locations of final aquatic AIM design points in the West Desert District, UT.

Step 7: Develop quality assurance and quality control (QA and QC) procedures and data management plans

Terrestrial - *Data management, quality assurance, and quality control for the terrestrial core indicators will follow the standard procedures in the [Terrestrial AIM Data Management Protocol] available on the AIM Landscape Toolbox.*

Supplemental indicators require additional data management and quality considerations. Distance to nearest sagebrush patch and distance to nearest juniper/tall structure will be captured in an Excel spreadsheet following the field season. Sagebrush shape will be electronically captured using DIMA along with the Line Point Intercept method. Supplemental training for field crews and field office staff will be made available after the AIM terrestrial core methods training to ensure that these methods are implemented successfully.

Aquatics - *Data management, quality assurance, and quality control for the aquatics core indicators will follow the standard procedures in the* Aquatic *Data Management Protocol.*

E. coli indicator data will be managed by the district aquatic ecologist.

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