**INTEGRATED TRAINING AREA MANAGEMENT**
**ITAM Learning Module**
**LCTA Scenario**

# Defining Monitoring Objectives

## Recommended Reading

ITAM Technical Reference Manual
Chapter 2: *Introduction to Resource Monitoring*

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. *Measuring and Monitoring Plant Populations*. BLM Technical Reference 1730-1, USDI Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO.

## Background

Monitoring should be objective-based. The success of a monitoring effort is based upon its ability to assess the success or failure of specific management objectives. Objectives must be realistic, specific, measurable, and written clearly. A limited suite of attributes should be chosen for assessing changes in the overall condition of plant communities. It is up to the individual who implements and manages resource monitoring to articulate objectives for his or her program. This collection of exercises illustrates how to develop and articulate both management and monitoring objectives. If good management objectives already exist at an installation, then the remaining task is to define monitoring objectives related to them. Monitoring objectives may also be influenced by original program goals, need for continuity with historic data, methods, and available resources.

## Problem Statement

How do I define monitoring objectives?

## Procedure:

1. Define or examine management goals and specific management objectives
2. Develop one of more monitoring objectives for each management objective
3. Examine monitoring objectives for all necessary components

### 1. Define Management Goals and Objectives

Management goals help to direct resource management by defining desired conditions or trends in resource conditions. Sources of information for setting objectives include existing management plans and environmental (e.g., NEPA) documents, ecological models, reference sites or comparison areas, related or similar species and communities, expert opinion, and

historic records and photographs (Elzinga et al. 1998). A complete management objective, which forms the basis for one or more monitoring objectives, should include the following components:

**what** will be measured – direct measurement of species/community or habitat indicator (indirect)
**location** or geographic area of interest – defines the limits to which results will be applied
**attributes** to be measured, e.g., size, density, cover, frequency, qualitative estimate of abundance, extent of area covered
**objective action -** maintain, increase, or decrease
**quantity/status -** measurable status or degree of change for attribute – can be quantitative or qualitative
**time frame -** length of time specified for management to prove effective.

Objectives can describe either a *desired condition* or a *change* relative to current conditions:

The first type can be described as **target or threshold** objectives. This type of objective uses a predetermined threshold to gauge the effectiveness of management. For example: *maintain the size of population A at 450 individuals; increase the acreage of open woodland to 6000 ha; maintain the presence of threatened species A and B at Site C.* The success of meeting the objective is assessed by comparing the current state of the measured attribute either to the desired state or an undesired state. Presence of the undesired state should serve as an indication that management should be altered.

The second type can be described as **change or trend** management objectives. This type of objective specifies a change relative to the existing situation. For example: *increase perennial grass cover by 40%; decrease severe off-road disturbance by 20%; decrease frequency of weed species Y by 50%.* Trend objectives are useful when little information is available to describe a desired future condition, or where the current status is less important than trends over time. Change detection objectives are often appropriate when a significant change in management occurs and change is anticipated. If preliminary sampling provides information about the population status, then a *change* objective may be rewritten as a *threshold* objective.

Based on experience drawn from a number of military installations, we can list some of the major management concerns related to resource condition and military land uses:

- off-road vehicle and other training impacts to vegetation and soils
- spread of noxious weeds or species which outcompete desirable vegetation
- changes in structural attributes of plant communities – loss of concealment resources, wildlife habitat
- impacts of altered fire intensities/frequencies and other natural processes
- soil erosion, sedimentation, and water quality impacts

In light of these management concerns, the following general management goals related to vegetation and soils were developed:

Examples of General Management Goals

1) Sustain and maintain healthy and diverse ecosystems.

2) Maintain soil stability and susceptibility to erosion at acceptable levels.

3) Maintain realistic and sustainable training environments for desired training loads.

4) Revegetate selected disturbed areas to pre-disturbance conditions.

5) Minimize the establishment and spread of undesirable non-native plants.

These general management goals need to be refined so that corresponding monitoring objectives can be developed to address specific needs. If the success or failure of the management objective cannot be gauged, then there is no way of knowing if management activities are effective, or if management goals are met.

## *Exercise 1*

Using the guidelines provided above and in the recommended reading, develop one or more management objective for each goal. Then compare your objectives to the examples of possible objectives presented below. Decide whether each of your objectives is a target objective or a change objective. Did you include all of the essential components in your management objectives? If not, in each case what is missing or needs clarification?

Possible Management Objectives for Goal #1

Maintain the current (1997) spatial distribution and abundance, i.e., acreage, of each major plant community from 1997-2002 (target objective).

Within each community type, maintain 1997-1999 native grass, forb, shrub, and tree cover from 1999-2004 (target objective).

Within each community type, maintain 1997-1999 native grass, forb, shrub, and tree diversity from 1999-2004 (target objective).

Increase the forb diversity of woodland communities by 25% between 1999 and 2009 (change objective)

In existing shrub communities, maintain current (1997-1999) densities for each shrub species from 1999-2004 (target objective).

Allow a decrease in the ranked abundance of *Chlorogalum purpureum var. purpureum* (Purple Amole) in each of the 5 permanent macroplots at the Jones Mountain Site of no more than 1 rank class between 1998 and 2000.

*notes*: In order to define objectives, definitions or indicators must be developed for what constitutes "healthy and diverse" ecosystems. In this case, cover by functional group has been chosen as an indicator of "healthy". Calculated diversity indices are chosen as indicators or

Possible Management Objectives for Goal #2

Within each training area, maintain current (1997-1999) soil erosion rates from 1999-2004 (target objective).

Within each community type, maintain current (1997-1999) levels of bare ground from 1999-2004 (target objective).

*notes*: Bare ground is used here as an index of soil stability.

Possible Management Objectives for Goal #3

Maintain the current (1997) areal extent of forest, woodland, and grassland communities from 1997-2002 (target objective).

In forested areas used for bivouac, maintain an overstory tree density of at least 40 trees/ha from 1997-2002 (target objective).

*notes*: "realistic and sustainable training environments" must be defined for this objective to be developed. In this case, vegetation structure – forest vs. woodland vs. grassland – is used to define "realism". Tree density may relate to realism and sustainability.

Possible Management Objectives for Goal #4

For revegetation sites, increase cover of desirable plant species to within 50% of undisturbed plant cover after three years of recovery (change objective).

For revegetation sites, provide at least 20% perennial grass cover, 10% shrub cover, and 5% perennial forb cover after 2 years of recovery (target objective).

For burned sites, increase plant canopy cover to 25% after 1 year (target objective).

*notes*: Plant taxa need to be specified for "desirable" plant; values for "undisturbed plant cover" also need to be defined.

Possible Management Objectives for Goal #5

Maintain the current distribution and abundance of weed species X on Fort USA from 1997 to 2002 – this could be treated as quantitative or qualitative, depending on the approach that is most feasible (target objective).

Decrease the number of hectares on Fort USA infested with species Y (species is common to abundant) to 400 ha (target objective).

For sites treated for weed infestations, decrease the density of target weed species by at least 50% one year after treatment (change objective).

Maintain the number of km of road shoulders with a knapweed (all species) ranked abundance of 5 or more (target objective) .

*notes*: Plant taxa need to be specified for "target" weed species.

## 2. Define Monitoring Objectives for Each Management Objective

These complete management objectives form the basis for monitoring or sampling objectives. In addition to the what, where, and when, a monitoring objective should specify information such as the target level of precision (acceptable error), power, confidence level (false change error rate), and the magnitude of change we want to detect. Without specified targets for these parameters, estimates of population parameters might have excessively large confidence intervals or low power (e.g., only a 20% chance of detecting the magnitude of change that was desired). The necessary components of monitoring objectives differ for target management objectives and change management objectives.

The sampling objective for target objectives is to estimate a parameter in the population, estimate a proportion, or to estimate total population size. This estimate is then compared to the threshold value specified. To accomplish this, it is necessary to specify the confidence level (i.e., how confident do you want to be that your confidence interval will include the true value?), and the confidence interval width (i.e., how close to the estimated mean do you want to be?).

Example:

> **Management objective:** Decrease the density of *Juniperus* trees less than 10cm in diameter in abandoned agricultural fields between 2000 and 2005.

**Monitoring objective:** Estimate the density of *Juniperus* trees less than 10cm in diameter. We want to be 90% confident that mean density is within 10% of the estimated true value.

The sampling objective for change objectives is to determine if there has been a change in a population parameter for two or more time periods. These objectives must include the desired power (missed change or Type II error), the acceptable false change errors rate (Type I error), and the desired minimum detectable change (MDC) (the smallest change you are hoping to detect).

Example:

**Management objective:** Increase the density of flowering individuals of *Tauschia hooveri* (Hoover's desert parsley) at the Yakima Ridge site by 25% between 1999 and 2009.

**Monitoring objective:** We want to be 90% confident of detecting a 25% increase in mean density with a false change error rate of 0.10. This objective specifies a power of 90%, a false change error rate of 10%, and an MDC of 20%.

If the sampling interval is not specified in the management objective, it should be specified in the monitoring objective (i.e., seasonally, annually, every 2 years, 5 years, etc.). The sampling interval can be less than the timeframe specified in the management objective. For example, if a given change is desired over a 6 year period, monitoring every 2 or 3 years may be appropriate to see if there has been progress toward the objective.

When monitoring does not involve sampling, the management objective should provide enough information to evaluate its success or failure. This is the case where qualitative assessments are done for areas or where a complete census is performed. Management objectives of this type therefore do not
need to provide additional components beyond *what, where, and when*.

## *Exercise 2*

Develop a monitoring objective for each of the management objectives listed below. After you are done, compare your monitoring objectives with those provided.

1. In grassland communities, decrease the frequency of *Bromus tectorum* (cheatgrass) by 30% from 1999-2002.

2. Maintain native grass and forb species diversity at 1999-2001 levels.

3. Maintain the area of minimally, moderately, severely, and completely, disturbed (e.g., off-road maneuver and assembly) areas at 1999 levels.

4. In areas subject to extensive off-road maneuvers, allow a decrease in the cover of native plants of no more than 30% relative to undisturbed conditions between 1999 and 2002 (compared to undisturbed areas).

5. In forested areas used for bivouac, maintain an overstory tree density of at least 40 trees/ha from 1997-2002.

6. In existing shrub communities, maintain current (1997-1999) densities for each shrub species from 1999-2004.

7. Increase the forb diversity of woodland communities by 25% between 1999 and 2009.

8. Increase the Jones Mountain population of purple amole to 500 individuals by the year 2003.

9. Decrease the ranked abundance of *Lythrum salacaria* (purple loosestrife) in each of the 4 permanent macroplots at the Ives Rd. Fen site 2 rank classes between 1998 and 2000.

10. Do not allow erosion status estimates (estimated loss/allowable loss) for each training area to exceed 100% in any given year from 1998-2008.

**Answers for paired management and monitoring objectives:**

1. In grassland communities, decrease the frequency of *Bromus tectorum* (cheatgrass) by 30% from 1999-2002.

   Be 80% certain of detecting a 30% decrease in frequency with a false change error rate of 0.20.

2. Maintain native grass and forb species diversity at 1997-1998 levels.

   Obtain estimates of grass and forb diversity at 2 year intervals with 90% confidence intervals no wider than ± 10% of the estimated diversity.

3. Maintain the area extent and distribution of minimally, moderately, severely, and completely, disturbed (e.g., off-road maneuver and assembly) areas at 1999 levels.

   Estimate annually the extent (i.e., number of square meters, ha) of disturbed lands in each disturbance category and map areas using GPS – the objective has all the information for evaluating results.

4. In areas subject to extensive off-road maneuvers, allow a decrease in the cover of native plants of no more than 30% relative to undisturbed conditions between 1999 and 2002 (compared to undisturbed areas).

   Be 80% confident of detecting a 30% relative decrease in native plant cover with a false-change error of 20% (20% chance of concluding that a change took place when in fact there was no change).

5. In forested areas used for bivouac, maintain an overstory tree density of at least 40 trees/ha from 1997-2002.

   We want to be 95% certain that the estimates are within 15% of the estimated true density.

6. In existing shrub communities, maintain current (1997-1999) densities for each shrub species from 1999-2004.

   We want to be 95% confident that annual density estimates are within 10% of the estimated mean density.

7. Increase the forb diversity of woodland communities by 25% between 1999 and 2004.

   We want to be 90% sure of detecting a 25% relative increase in forb diversity. We are willing to accept a 10% chance of a false-change error.

8. Increase the Jones Mountain population of *Chlorogalum purpureum var. purpureum* (purple amole) to 500 individuals by the year 2003.

   We want to be 95% confident that the population estimate is within ± 10% of the estimated true value. This objective applies where sampling is used. If all of the individuals in the population are counted (census) the count is simply compared to the target value.

9. Decrease the ranked abundance of *Lythrum salacaria* (purple loosestrife) in each of the 4 permanent macroplots at the Ives Rd. Fen site by 2 rank classes between 1998 and 2000.

   Estimate the ranked abundance of purple loosestrife in each macroplot – the objective has all the information for evaluating results. Estimates could be made annually or in 1998 and 2000.

10. Do not allow erosion status estimates (estimated loss/allowable loss) for each training area to exceed 100% in any given year from 1998-2008.

    Estimate erosion status annually for each training area. We want to be 90% confident that the estimate is within ± 20% of the estimated true value.

**3. Examine monitoring objectives for all necessary components**

## *Exercise 3*

State whether the following are management or monitoring objectives and determine what is missing, if anything:

1. Increase native grasses in disturbed areas between 1998 and 2000.

2. Maintain deciduous overstory tree canopy cover at the Camp Darby bivouac site between 1997 and 2007.

3. Monitor wind erosion repair sites to evaluate different revegetation treatments.

4. Revegetate disturbed areas on Range 11.

5. Increase Karner Blue butterfly (Lycaeides melissa samuelis) habitat by 400 hectares.

6. At 2 year intervals, we want to estimate the density of oak seedlings in burned and unburned woodland communities every 5 years and we want the estimate to be within 20% of the true value.

7. Allow a decrease of no more than 25% in the density of mature big sagebrush (*Artemisia tridentata*) plants greater than 0.3m tall in existing shrublands.

8. Estimate the cover of bare ground at all firing points.

**Answers**

1. What attribute of native grasses: cover, density, etc.? What qualifies as "disturbed"? Increase by how much? (management)

2. This objective is complete (management).

3. Everything is missing except the location. Measure what attribute of what variable? When? Time frame? How often? (monitoring)

4. This is closer to a management action than an objective.

5. Where – throughout the installation or in a specific area? By when should habitat be expanded? (management)

6. Level of confidence for the estimate? (monitoring)

7. What is the time frame – over a 1 year period, 5 year period? (management)

8. Confidence level? Desired confidence interval width or acceptable error? How often will estimates be made?

## Conclusions

Well-defined objectives strengthen the purpose and efficiency of any monitoring program. Moreover, they provide benchmarks for measuring the effectiveness of management actions and sampling approaches. Although monitoring objectives are ideally specified before data collection begins, it is sometimes the case that objectives change over time. By having a combination of qualitative and quantitative objectives that examine both robust (i.e., indicator sensitive to a wide variety of disturbances, but not too sensitive) and sensitive attributes, the program will have a better chance of weathering oscillations in program resources. Sampling objectives also help to fine-tune sampling designs in the early stages of a project. Once pilot or first-year data is available, it can be used in sample size equations to determine how many samples are necessary to meet the requirements specified in the monitoring objective. Management responses can also be added to each set of objectives to indicate actions to take if management objectives are not met.