Agency/Organization: Desert Research Institute
Project Name: Science Advisor
Project Number: 2005-DRI-574A-P
Reporting Period: July 1 – September 30, 2007
Project Contact Name and Information:
Mark Stone, Division of Hydrological Sciences, Desert Research Institute,
775 E Flamingo Rd, Las Vegas, NV 89119.
Mark.Stone@dri.edu, 702 862 5457.

Design Recommendations for Development of a Programmatic Effectiveness Monitoring Strategy for the Clark County Desert Conservation Program Multiple Species Habitat Conservation Plan

Introduction

The goal of this project was the formulation of recommendations for the design of a programmatic effectiveness monitoring strategy for the Clark County Desert Conservation Program's Multiple Species Habitat Conservation Plan (MSHCP). The strategy described in this report contains both project- and programmatic- level components. The programmatic effectiveness monitoring strategy project was one of the tasks undertaken by the Desert Research Institute (DRI) in its role as Science Advisor to the County's Desert Conservation Program's MSHCP.

This report opens with a review of the current status of effectiveness monitoring for Clark County's MSHCP-funded projects, which was written by the County. Gaps in the process are identified, and recommendations for addressing these gaps at the project - level are put forward. The section on programmatic-level effectiveness monitoring, written by DRI, includes results from a workshop involving stakeholders (and outside experts) in the County's Desert Conservation Program's MSHCP, at which examples from other programs, the development and selection of indicators for various levels of effectiveness, and issues/concerns were discussed. Recommendations presented in this report result partly from this workshop. This report concludes with discussion of the business objectives and functional and technical requirements for a programmatic effectiveness monitoring strategy tracking system for the County's MSHCP, and some general recommendations.

Recommendations for project-level effectiveness monitoring

Current Status of Effectiveness Monitoring for Clark County's MSHCP-funded Projects.
An analysis of completed and active MSHCP-funded projects was conducted by Desert Conservation Program (DCP) staff using Biennial Progress Reports (Clark County, 2002; 2004; 2006a; and 2008) and the scopes of work for active projects on September 3, 2008. Those project reports that reported collecting effectiveness data were examined to determine if an experimental approach was used to collect those data. A total of 36 projects reported collecting effectiveness data, and 10 of those reported using an experimental approach (Table 1). A complete list of these projects is provided in Table 2. The 1999-2001 Biennial Progress Report (Clark County, 2002) stated that several pre-MSHCP desert tortoise exclosure fencing installation projects had collected effectiveness data, and subsequent projects had used that information to modify the approach to fencing installation. The individual projects were not described in that report, and this information was not examined further, but is mentioned here to assist future studies of MSHCP-project effectiveness monitoring.

Table 1. Number of MSHCP-funded projects reporting that project-level effectiveness data were collected. Number of those projects reporting an experimental design are shown in parentheses. Data collected from past and active projects September 3, 2008.

MSHCP BUDGET BIENNIUM	1999-2001	2001-2003	2003-2005	2005-2007	2007-2009	TOTAL
ANIMAL DAMAGE CONTROL			1	1		**2**
BURRO MANAGEMENT				1		**1**
GRAZING REMOVAL			2(2)			**2(2)**
HABITAT RESTORATION	2(1)	2	4(1)	3(1)		**11(3)**
LAW ENFORCEMENT	1			1		**2**
PUBLIC INFORMATION AND EDUCATION			1			**1**
RARE PLANT TRANSPLANTS	1	1(1)				**2(1)**
TORTOISE MONITORING		1(1)	1			**2(1)**
TORTOISE TRANSLOCATION	1(1)		1(1)			**2(2)**
TRAIL MAINTENANCE				1		**1**
TRAINING OF TORTOISE MONITORS			2			**2**
WEED CONTROL	1	1	2	4(1)		**8(1)**
NUMBER OF PROJECTS WITH PROJECT-EFFECTIVENESS INFORMATION	**6**	**5**	**14**	**11**	**0**	**36**
NUMBER OF ABOVE WITH EXPERIMENTAL APPROACHES	**(2)**	**(2)**	**(4)**	**(2)**	**0**	**(10)**

Table 2. Past or active MSHCP-funded projects that reported collection of effectiveness data as of September 3, 2008.

PROJECT TITLE	PROJECT NUMBER	MSHCP BUDGET BIENNIUM
Distribution & Status of Migrant Birds	1999-UNLVGS-1-A	1999-2001
PabCo Road Bearpoppy Restoration	1999-BLM-1-F	1999-2001
Law Enforcement	1999-BLM-1-D	1999-2001
Restore and Reintroduce Springsnails and Develop Monitoring Protocol	1999-UNLVGS-1-A	1999-2001
Desert Tortoise Translocation	1999-BRRC-1-C	1999-2001
Riparian Habitat Restoration and Public Education	1999-MRRE-1-B	1999-2001
Designating Motorized Vehicle Routes; Amended from Habitat Protection-Cold & Willow Creeks	2001-USDAU-1-D	2001-2003
Upland Restoration in Critical Desert Tortoise Habitat	2001-BLM-4-A	2001-2003
Buckwheat Salvage/Transplant Trial	2001-LVSP-1-B	2001-2003
Tortoise Monitoring	2001-UNR_BRRC-2-A	2001-2003
Control of Sahara mustard, *Brassica tournefortii*, In Rare Plant Habitats	2001-NPSLM-1-A	2001-2003
Assist in Development of Wildlife Damage Management for Threatened Endangered Species from Predation or Parasitism	2003-USDA_WS-332	2003-2005
Evaluating the Impact of Cattle Grazing on Vegetation	2003-BLM-361	2003-2005

and Vegetative Recovery Following Removal of Cattle Grazing		
Upland Restoration in Critical Desert Tortoise Habitat	2003-BLM-366	2003-2005
Red Rocks to the Summit	2003-UNR-369	2003-2005
Habitat Enhancement in the Las Vegas Wash	2003-SNWA-345	2003-2005
Relict Leopard Frog Monitoring and Management	2003-NPS-179	2003-2005
Restoration of Fragmented Upland Habitats on Federal Lands	2003-BLM-368	2003-2005
Public Information and Education Strategic Planning and Program Assessment	2003-CC-373-P	2003-2005
Increasing Effectiveness and Economy in Density Monitoring of the Desert Tortoise	2003-UNR-BRRC-257	2003-2005
Translocation, Long-term Monitoring, Desert Tortoise Density Evaluation, and Establishment of New LSTSs	2003-UNR-289	2003-2005
Baseline Density Monitoring: Southern Nevada Desert Wildlife Management Area — Populations of the Desert Tortoise	2003-UNR_BRRC-252	2003-2005
Development of a Range-wide Desert Tortoise Monitoring Training Program	2003-UNR-BRRC-249	2003-2005
Muddy River Riparian Protection & Restoration	2003-MRREIAC-337	2003-2005
Spring-fed Wetlands and Riparian Restoration	2003-NPS-227	2003-2005
Provide Assistance in the development and application of Wildlife Damage Management for the protection of identified threatened and/or endangered species from predation or parasitism within Clark County	2005-USDA_ADC-598	2005-2007
Burro Removal at Lake Mead National Recreation Area	2005-NPS-255	2005-2007
Habitat Manipulations for Relict Leopard Frog Populations	2005-UNLV-597	2005-2007
Restoration in Desert Tortoise Critical Habitat	2005-BLM-500	2005-2007
Monitoring of Illegal Ground Disturbance in Response to Management Actions	2005-NPS-526	2005-2007
Law Enforcement	2005-BLM-496	2005-2007
Bristlecone Pine Habitat Protection Project	2005-USFS-SMNRA-490	2005-2007
Sahara Mustard Control In Rare Plant Habitats	2005-NPS-533	2005-2007
Spring-fed Wetlands and Riparian Restoration	2005-NPS-573	2005-2007
Interagency Weed Sentry Project	2005-NPS-537	2005-2007
Effectiveness Monitoring for Saltcedar and Knapweed Control on the Upper Muddy River Floodplain	2005-TNC-572	2005-2007

Many of the early (pre-2005-2007 biennium) projects gathered observational information on success and appeared to have focused on making passive adaptive management (Walters, 1986) improvements to mitigation action methods. The 2006 Adaptive Management Report (Clark County, 2006b) identified ten projects in the 2003-2005 biennium that were to address project-effectiveness monitoring. These ten projects are shown in Table 3. Eight additional 2003-2005 biennium projects reported effectiveness information and are shown in Table 4.

Table 3. 2003-2005 Projects That Proposed to Address Effectiveness Monitoring.

Project Title:	**Project Number**	**Effectiveness monitoring in proposal:**	**Outcome**
Upland Restoration in Critical Desert Tortoise Habitat	2003-BLM-366	Effectiveness monitoring strategy	75% of monitored sites were found to be recovering. Unclear if changes were made in response to this information. No specific recommendations made to improve future actions.
Increasing Effectiveness and Economy in Density Monitoring of the Desert Tortoise	2003-UNR-BRRC-257	The results of this project will be published in the U. S. Fish and Wildlife Service review of range-wide tortoise monitoring in late 2005.	Changes to monitoring methods were made in response to the collected information
Development of a Range-wide Desert Tortoise Monitoring Training Program (Sect 7 UNR)	2003-UNR-BRRC-249	The results of desert tortoise monitoring (range-wide) are used to evaluate the effectiveness of this training effort and changes incorporated for next year's workshop. One could expect to see the results of this evaluation in the U. S. Fish and Wildlife Service review of range-wide tortoise monitoring in late 2005.	Changes to monitoring training methods were made in response to the collected information.
Law Enforcement (Sect 10 BLM)	2003-BLM-360	Effectiveness monitoring strategy	No effectiveness information reported.
Restoration of Fragmented Upland Habitats on Federal Lands (Sect 10 BLM)	2003-BLM-368	Effectiveness monitoring strategy	Over 75% of mesquite acacia ecosystem restoration sites showed no new disturbance. Only 8% of gypsum habitat restoration sites showed no new disturbance. Recommendations made to improve success rate of future actions.
Spring-fed Wetlands and Riparian Restoration (Sect 10 NPS)	2003-NPS-227	Effectiveness monitoring and scientific research were integrated into the project to address specific needs.	Information collected was used for site-specific needs, and reported successful elimination of new weed populations in isolated areas.
Clark County Multiple Species Habitat Conservation Plan (MSHCP), Adaptive Management Coordination, Science Advice and	2003-CC-439 and 2003-UNR_BRRC-321	Science Advisor contract products and this Adaptive Management Report	Assessment of information and guidance to improve project selection and negotiation of future contracts and interlocal agreements made.

Effectiveness Monitoring Strategy Development (SNPLMA Clark County)			
Lake Mead National Recreation Area Data Collection and Analysis (SNPLMA NPS)	2003-NPS-235	These data are needed to gauge effectiveness of conservation measures outlined in the MSHCP and to provide information to guide planning and development in Clark County.	Produced no effectiveness assessments as an outcome.
Wildlife Inventory Monitoring and Management (SNPLMA NPS)	2003-NPS-229	Rare and sensitive species living on the recreation area must be monitored in order to detect problems which require management attention, and to determine the effectiveness of ongoing management activities.	Produced no effectiveness assessments as an outcome.
Assist in Development of Wildlife Damage Management for Threatened Endangered Species from Predation or Parasitism (SNPLMA USDA_ADC)	2003-USDA-WS-332	Effectiveness monitoring, involving gut content analysis, has been included in the project. Effectiveness monitoring is being altered to include gut content analysis and possible DNA marker coding.	Collected gut contents were stored for possible future analysis but funding (for analysis) had not been secured at the time of reporting.

Table 4. Additional 2003-2005 Projects That Reported Effectiveness Information.

Project Title:	**Project Number**	**Outcome**
Evaluating the Impact of Cattle Grazing on Vegetation and Vegetative Recovery Following Removal of Cattle Grazing	2003-BLM-361	Reports removal of grazing did not improve habitat quality. (See text for results of technical peer review of product.)
Red Rocks to the Summit	2003-UNR-369	Reports that compared spring management methods and shared results with land managers. Unclear if management methods were successful.
Habitat Enhancement in the Las Vegas Wash	2003-SNWA-345	Reports that monitoring data indicate that methods were successful.
Relict Leopard Frog Monitoring and Management	2003-NPS-179	States that habitat was enhanced at two sites.
Public Information and Education Strategic Planning and Program Assessment	2003-CC-373-P	Found that Public Information and Education program activities were effective in achieving program objectives.
Translocation, Long-term Monitoring, Desert Tortoise	2003-UNR-289	States that translocation is effective.

Density Evaluation, and Establishment of New LSTSs		
Baseline Density Monitoring: Southern Nevada Desert Wildlife Management Area — Populations of the Desert Tortoise	2003-UNR_BRRC-252	States that effectiveness data collected during season and information was used to improve monitoring techniques.
Muddy River Riparian Protection & Restoration	2003-MRREIAC-337	States that actions were effective.

Of the ten 2003-2005 projects that proposed to collect effectiveness information prior to project initiation, only seven did so. Because these seven projects appear to have collected effectiveness information for the purpose of improving mitigation action methods, it appears that the underlying assumption was that the mitigation action would be fundamentally effective in achieving MSHCP goals or objectives. None of these projects were designed to test the overall effectiveness of the mitigation actions. Of the eight additional 2003-2005 biennium projects that reported effectiveness results, five also were focused on project-specific methods. The remaining three (2003-BLM-361, 2003-CC-373, and 2003-UNR-289) addressed mitigation activities at a larger scale and are discussed below.

The BLM's grazing evaluation project (2003-BLM-361) reports that the results of data analysis show that cattle had no impact on desert tortoise habitat nor on desert tortoise populations, but an MSHCP external technical review of the project found that the methods used to collect data for this project were not appropriate to answer questions about desert tortoise habitat quality or desert tortoise populations. Thus, this project as designed and implemented could neither refute nor support the effectiveness of grazing removal for desert tortoise habitat improvement or desert tortoise population increases.

The Clark County public information and education program assessment project (2003-CC-373) was an external evaluation of the effectiveness of a variety of program activities in achieving the program's objectives. As described in the previous Adaptive Management Report (Clark County 2006b), the objectives of the public information and education program were found to have been met, but the degree to which these program objectives address the overall MSHCP goals and objectives is unclear.

The University of Nevada Reno translocation assessment project (2003-UNR-289) evaluated the effectiveness of translocation efforts and methods in Clark County, and found that those efforts and methods were effective. This project used an experimental design that included control groups, but has not been published in the peer-review literature. No external technical review of this project has been conducted by the MSHCP, but has been provided to the US Fish and Wildlife's Desert Tortoise Recovery Office's Science Advisory Committee.

In addition, several of the 2005-2007 biennium projects include experimental designs to test the effectiveness of various mitigation action methods. Both the tamarisk control

method effectiveness projects (2005-TNC-572 and 2005-USGS-552) are using or will be using an active adaptive management approach (Walters, 1986) to compare various weed control methods that include establishment of native vegetation cover as success measures.

Previous Adaptive Management Reports (University of Nevada, Reno, 2004; Clark County, 2006b) provided recommendations for an improved, more rigorous approach to project-effectiveness monitoring. These recommendations included:

- Does the project description address the goals of the MSHCP to
    - maintain the long-term net habitat value of the ecosystems in Clark County with a particular emphasis on covered species and
    - recover listed species and conserve unlisted covered species?
- Is documentation available that supports the assertion that the goals of the MSHCP are addressed; that is, are there reports and/or maps as appropriate?
- If the project is an implementation of conservation measures, are the goals and objectives sufficiently clear that it is possible to design a monitoring program to gauge the effectiveness of those conservation measures?
- If the project is itself described as monitoring, does it contain the elements of a useful monitoring program?
    - clearly stated goals and objectives for management actions,
    - well-defined conceptual models,
    - good justification of the selection of indicators, and
    - sampling designs that adequately address scope and resolution.

Beginning with the 2005-2007 biennium projects, all contracts and interlocal agreements are required to include objective statements that utilize the MSHCP's lists of species, ecosystems, threats and/or conservation actions as appropriate. This requirement has been applied via a DCP contract and interlocal agreement development procedure and checklist. This approach provides more explicit objective statements received in previous biennia, a clear tie to elements of the MSHCP in the absence of more refined MSHCP programmatic goals and objectives, and a statement of how the project assumes these elements are related. For instance, a project to implement weed control activities in rare plant habitats might have an objective statement such as:

> *This project will implement conservation action NPS(###) in ecosystem (XXXXX) to reduce threat (###g) and benefit species (YYYYY and ZZZZZ).*

This objective statement shows that the project is clearly related to the MSHCP goals to benefit the ecosystem health of ecosystem (XXXXX), and the status of species (YYYYY and ZZZZZ). This objective statement could also be used to craft the very basic conceptual model shown in Figure 1.

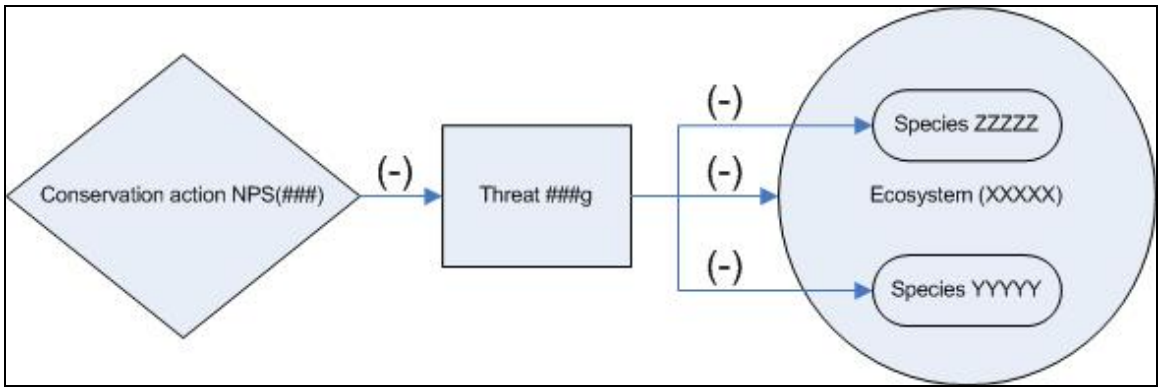

Figure 1. Conceptual model derived from sample project objective statement: "This project will implement conservation action NPS(###) in ecosystem (XXXXX) to reduce threat (###g) and benefit species (YYYYY and ZZZZZ)." Negative or reducing impacts are indicated by "(-)" symbols.

Current gaps in project-level effectiveness monitoring

While mitigation action projects are now required to state objectives in a consistent fashion using elements from the MSHCP, there is no clear link to how these objectives link to an MSHCP goal or objective – this link is assumed. Refinement of MSHCP objectives should be made to a resolution that would allow for more robust linking to project objectives.

There is currently no requirement or incentive to document complete first iteration conceptual models of how project actions address MSHCP elements. In addition, there is currently no formal mechanism to design effectiveness monitoring or data collection to evaluate any portion of the conceptual models upon which these objectives are based. Finally, there is no formal mechanism to report how the results of effectiveness monitoring or data collection were evaluated and used to impact future actions or decisions. Recommendations to address these gaps are described below.

Conclusions

At the present time it is not possible to identify conclusions that may be drawn from the results of project-level effectiveness monitoring and other available data regarding the effectiveness of MSHCP projects in achieving project-level goals and objectives. Some data which may provide information are available, but very few projects included goal statements and objectives, and most of those that did were either unrelated to project activities or were unattainable in the two-year project timeframe.

It may be inherently "easier" to prioritize project-level effectiveness efforts for projects which are associated with low uncertainty and/or low risk actions. However there may be limited lessons to be learnt and less information for management generated as a result of the "safe" projects. In general, if conceptual models are used to set up questions and hypotheses, higher risk and uncertainty projects will tend to generate more questions which will, in turn, ensure that they are accorded priority.

Recommendations for addressing gaps in effectiveness monitoring at project level in the next two MSHCP Implementation Plan and Budgets (2007-2009, 2009-2011)

The DCP has been actively enforcing the technical conditions for funding that were imposed on species monitoring projects approved in the 2005-2007 biennium. Many of these technical conditions for funding were to address gaps and deficiencies in species monitoring projects similar to the above gaps in effectiveness. This enforcement thus provides a model for how the above gaps in project-level effectiveness monitoring might be addressed in the future. In short, to address technical conditions for species monitoring projects, the following steps were taken.

1. Require an early deliverable: conceptual species habitat model containing relevant species life history components, ecosystem processes and threats to species status
2. Identify a portion of the above model to be better informed by monitoring data collection. In most cases, this is a component that would predict species distribution.
3. Require a monitoring design to incorporate a "test" of the model component by requiring 20% of monitoring effort to take place in areas not within the current model (outside of known habitat or potential habitat as currently understood.)
4. Annually, require reevaluation of conceptual species habitat model and assessment of monitoring protocols.

This approach could be modified in the following way to improve the rigor of project-level effectiveness monitoring:

1. Require before implementation starts, possibly prior to recommending project for funding: conceptual model of how mitigation actions to be implemented in the project address MSHCP goals and objectives that include the threats that would be addressed by the actions, and the species and ecosystems that would benefit from the actions. These models must contain a link to the MSHCP programmatic goal(s) and/or objective(s) that would be impacted by the mitigation actions.
2. Identify a portion of the above model that contains the key effectiveness attributes or indicators of effectiveness that could be measured to determine the project's effectiveness.
3. If there is a high degree of uncertainty regarding the project action(s)' effectiveness, require a statistically valid monitoring protocol to gather effectiveness data. If not, less rigorous observations may be used.
4. Require documentation of a reevaluation of conceptual model and project methods' effectiveness based upon each year's data collection, and other available information. As with several of the species monitoring projects, this step can be addressed via a workshop with invited agency staff and other experts. This step will close the loop in the adaptive management cycle in a transparent fashion.

In addition, when the MSHCP's programmatic objectives are refined, these conceptual models for mitigation project activities should also be revised to evaluate whether the current mitigation actions are appropriate to achieve MSHCP goals. This iterative and

transparent approach to effectiveness monitoring will allow program participants and external observers to address key uncertainties, and document when iterative evaluations of available information have confirmed the MSHCP's approach to mitigation.

Recommendations for rolling-up project-level effectiveness monitoring to inform programmatic-level effectiveness monitoring

By no means do all projects lend themselves to the "rolling-up" process, but there is one which may provide a useful example for discussion in this context. The desert tortoise exclusion fencing program, which began in 1999, had completed 308 miles of fencing by March 2008. If monitoring had been structured round the hypothesis that fencing reduced tortoise mortality, a biological effectiveness indicator of project success might have been tortoise population increase in fenced areas (or at a minimum, no loss). In a similar context, miles of fencing completed might be a useful administrative indicator of project performance. In this case, it is possible that aggregating results from these two indicators across the individual fencing projects would provide a program-level measure of effectiveness. However, desert tortoise monitoring effort is directed toward assessing overall status, rather than attempting to correlate with or test why status might be changing (or investigating cause-effect issues) – making roll-up difficult if not impossible.

On a cautionary note – there are many factors which contribute to an observed increase in animal populations, for example: increase in food sources and fertility, decrease in predators, optimal climate conditions, species-specific periodicity. As appropriate, these would need to be considered and shown to be irrelevant for a cause-effect relationship for roadside fencing and increased tortoise numbers to be clearly demonstrated. Interpretation of population trend data will be revised in the program-level monitoring section of this report.

Recommendations for programmatic-level effectiveness monitoring

Approach

The first activity for this part of the task was to generate a framework document for workshop participants, to be sent out before the workshop, including description of effectiveness monitoring in the context of other programs related to habitat conservation plans and similar efforts, in the bigger picture context of adaptive management. A workshop to discuss these topics in the context of a future program for the County was hosted by the DRI at its Las Vegas campus on August 5th, 2008. For the present, the specific goal underpinning programmatic effectiveness monitoring (PEM) was summarized as:

- For the MSHCP as a whole (including take and conservation actions) to have a net neutral or positive impact

The desired outcome of the workshop was a draft plan of what could be measured and how, excluding metrics. There were 23 participants (see Appendix 1 for a list), including permittees, agency representatives and invited experts from the science and research community.

MSHCP-specific, measurable, programmatic objectives

The MSHCP objectives are of fundamental importance as they provide the context in which progress (effectiveness) is measured. PEM itself is part of planning in the classic adaptive management "donut" shown in Figure 2, where it is inextricably linked not only to objectives, but also to development of conceptual models and selection of indicators.

However, one constraint operating on the selection of objectives for the County is the low level of its control over the trends of the various impacting activities, which handicaps ability to revise and replan (Figure 2).

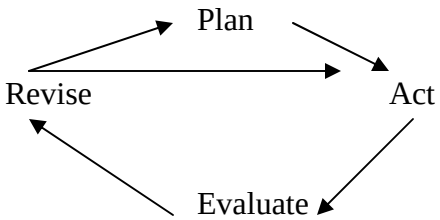

Figure 2. A simple schematic of the adaptive management process.

Other Habitat Conservation Plans (HCPs) and related programs used as examples for the framework document and workshop had a range of overarching objectives including those for the Coachella Valley which are broad biologically and management oriented (http://www.cvmshcp.org/Plan_Documents.htm); the Chesapeake Bay Foundation whose 2006 objective was attainment of a specific numeric range for a "health index" comprising values from 12 indicators in three major categories (http://omalley.3cdn.net/1857d3b7f96ee13e1f_02m6bhe5j.pdf); and Western Riverside County (the Riverside example was discussed in the workshop) which had three goals, one each in biologic, economic and social contexts, as follows (quoted from: http://www.rctlma.org/mshcp/index.html):

- In the MSHCP Plan Area, Conserve Covered Species and their Habitats.
- Improve the future economic development in the County by providing an efficient, streamlined regulatory process through which development can proceed in an efficient way. The MSHCP and the General Plan will provide the County with a clearly articulated blueprint describing where future development should and should not occur.
- Provide for permanent open space, community edges, and recreational opportunities, which contribute to maintaining the community character of Western Riverside County.

A measure of programmatic effectiveness for the Western Riverside County MSHCP would therefore involve values for biological, economic and social components, potentially with different indicators and associated metrics. This example was discussed during the August, 2008, workshop and participants seemed to consider objectives in these three areas to be suitable for the Clark County MSHCP.

The workshop process was useful in regard to a further critical component of objective definition, that of stakeholder involvement and understanding. Inevitably people with different backgrounds and experience have different perspectives, and the contrast between the needs and concerns expressed by representatives from "scientific", "land management" and "city management" entities comprising County MSHCP stakeholders was clearly expressed during workshop discussion. Openly sharing ideas and discussing options is a critical part of the process, which will enhance the overall result and contribute to its success (Williams et al., 2007).

Programmatic performance measures

Indicator values – taken singly and/or combined into indices – can provide a quantifiable measure for performance, but care needs to be taken in extrapolating these values to the direct and indirect impacts resulting from management actions. During the August, 2008 workshop, Jim Karr used examples from the Kissimmee River, Chesapeake Bay and Lake Tahoe, to illustrate his point that typical program goals such as "restore distance x of stream channel and riparian corridor" or "reduce phosphorus levels to xyz" might appear 100% successful if measured by a limited suite of indicators, but would have entirely missed the broader ecological perspective and are not necessarily clearly linked to management actions.

The broader ecological perspective was the context for Jim's presentation, in which he discussed advantages of considering whole assemblages rather than individual species, the need for multiple tools, assessment rather than monitoring, and the use of dose-response curves for measuring biological condition. Jim used examples of benthic invertebrates to show how an assessment of biological condition based on assemblage metrics provided more information than would have been available as a result of a classic habitat monitoring program.

Not only is the program goal itself important, but so also is the analysis of data to evaluate those goals. Jim proposed that gradients and the dose-response curve are critical, and pointed out that combining measures for a metric will reduce the variance for each of the values for contributing variables. Conceptual models and metrics should be used cautiously, and the adoption of an assessment strategy (rather than a monitoring program) which demands a rigorous definition of goals and endpoints and sampling design and is part of the conceptual shift from considering parts of the system to considering the processes operating therein at system level.

For the County, this process-level bigger picture context includes several components which must be addressed by a PEM strategy. In addition to a suite of population variables for each covered species, assemblages of species are important and provide information concerning habitat and ecological function (including the degree and impact of threats). The importance of habitat cannot be overstated. Take is based on habitat and therefore it is recommended that the County's PEM strategy relates strongly to habitat (as well as species) and at the landscape scale.

Ultimately, PEM is tied to project-level effectiveness. It is also tied to the goals, objectives and research priorities the program has for the funding cycle. These topics will be discussed in more detail in the last section of this report.

Programmatic monitoring design

Monitoring is defined as "…the systematic and usually repetitive collection of information, typically used to track the status of a variable or system." (Atkinson et al., 2004). Atkinson and her co-authors (2004) point out that monitoring is a long-term commitment and is closely linked to the development of conceptual models of ecosystem function or species' life histories, identification of conservation strategies and management decision-making. There are feedback loops in this process, with monitoring information resulting in changes to all components of the overall adaptive management plan.

Change is implicit in monitoring programs, but change from what? The "what" might be considered as a baseline against which change is measured. The acquisition and use of baseline data was discussed at the August, 2008 workshop, and several suggestions were made for suitable sites and studies, including use of the Mojave National Preserve as a surrogate for the Las Vegas valley area. Baseline data does not necessarily have to be acquired from a "pre management" timeframe, nor from a "pristine" area. It may be inferred from long-term monitoring data, but there is considerable investment of time and personnel required to choose and understand baseline data, and the significance (ecologically as well as from a management perspective) of species' and/or system trends in relation to that data.

Cam Barrows illustrated these concepts eloquently in his presentation during the August, 2008 workshop. Initially showing relatively short segments of his Fringe-toed lizard (*Uma scoparia*) species population trend graph (from the **"**dotted**"** line in Figure 3) with apparently strong upward or downward trends, Cam pointed out that incorrect and totally out of context assessments of management actions might be made based on such data. When plotted with rainfall amounts (Figure 3), and considered with other relevant data and over a longer time period, it was concluded that this lizard responds to the increased food availability resulting from high rainfall years. This is a natural variation, with little cause and effect link to any management decision or action, nor to changes in threats.

Habitats or ecosystems are monitored using indicators which provide information on structural and compositional elements reflecting underlying ecological processes (Mulder et al., 1999) but not necessarily as a surrogate for species population metrics (Atkinson et al., 2004). However, Mulder and his co-authors (2004) suggest the relationship between species and habitat may be addressed by integrating data from species-related indicators with the species' required habitat and projecting change in habitat at a range of spatial scales. These authors caution that use of habitat as a surrogate for species requires considerable investment in model building, relating population to habitat variables to develop wildlife relation models.

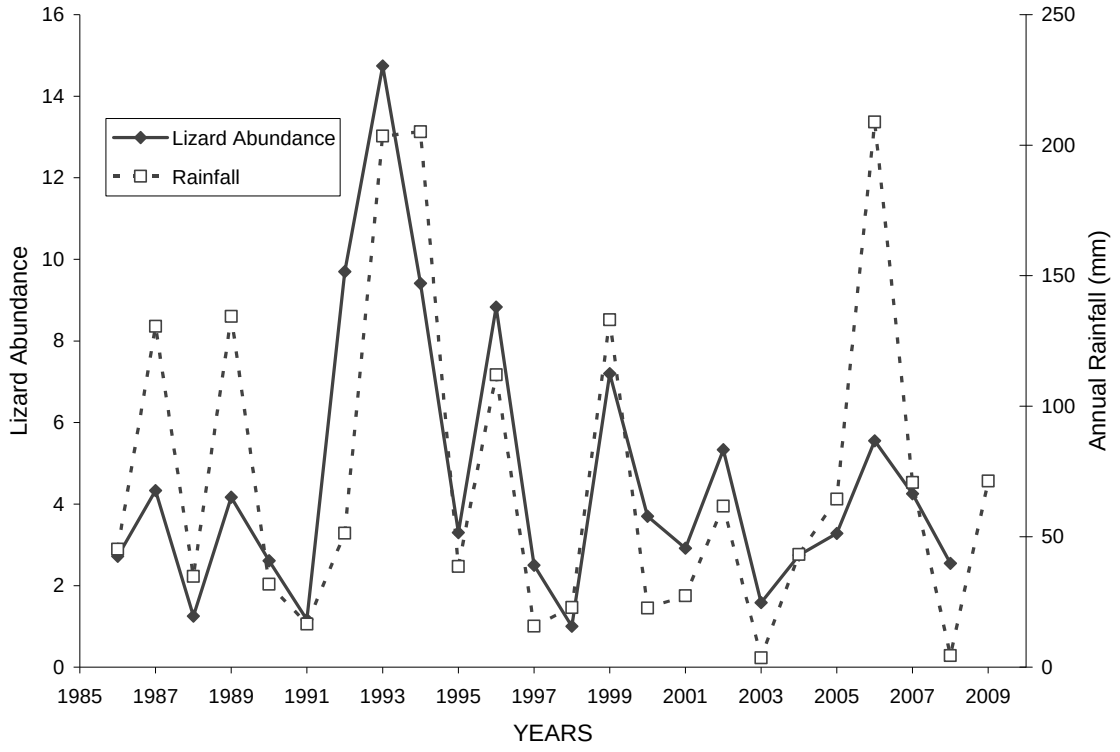

Figure 3. Fringe-toed lizard abundance plotted with rainfall for the period 1985 through 2009. (Source: Cameron Barrows, TNC)

Establishing the significance of trends, particularly for rare, elusive and/or marginal species is not a trivial task, as it may be influenced by factors which are outside the monitoring program, or not in "obvious" association with species' distribution patterns. The process is directly related to conceptual models and is considerably facilitated by hypothesis formulation and testing and model updating, in the adaptive management context.

Indicator selection criteria

There is considerable literature on indicator selection for monitoring programs and, in general, a tendency to select far too many. Examples of programs which have expended a huge amount of effort collecting data from multiple indicators, and then found it difficult to interpret the results, range from the Environmental Protection Agency's Environmental Monitoring and Assessment Program to the Chesapeake Bay Program.

Indicators were a topic of discussion during the August, 2008 workshop and their important attributes were summarized by Jim Karr using one of his recent papers as source material (Karr, 2008). Indicators should be:

- Measureable
- Integrative
- Ecologically relevant

- Socially relevant
- Interpretable
- Cost effective
- Anticipatory
- Collected at appropriate geographical scales
- Collected at appropriate temporal scales and able to detect trends
- Able to detect trends
- Provide quantitative data
- Statistically rigorous
- Reliable
- Comparable
- Useful as diagnostic tools
- Based upon empirical and conceptual ecological foundations
- Relate to real ecological systems
- Sensitive to stressors
- Have an unobtrusive collection strategy

Although some of these have a clear ecological context, there are overall general characteristics which also apply to social and/or economic indicators. It should be pointed out that these indicator characteristics are very similar to those developed as a part of the EPA Environmental Monitoring and Assessment Program. However, those were primarily based on a landscape context rather than "program" or "management".

The data acquisition process for most suites of indicators can be quite variable. Some need measurement annually, some weekly, some seasonally – some only after certain conditions are met or events have taken place, such as rainfall. There is also variability in how long each set of measurements takes to complete, and their spatial distribution. Coordination and frequent communication among partner agencies/entities on data collection and the potential for synergy is highly recommended. It may be that one team could perform data collection for another, increasing efficiency and avoiding duplication of effort.

Well designed program goals should help to constrain the number and nature of indicators for PEM, so that the information collected pertains to variables that the MSHCP is able to influence. Realistically a lot of the data collected by most ecological monitoring programs do not directly contribute to PEM. Ancilliary information that provides context for indicator data will increase the weight of evidence and strengthen inferences concerning interpretation and cause-effect linkages with management actions.

Programmatic design for data analysis

In general, data analysis follows a pattern. Data are collected, integrated across time and space and potential trends are identified. Current understanding of ecosystem-habitat-species relationships, derived from models and professional experience of the investigators and analysts, is of critical importance as it will constrain assumptions and

permit estimation of confidence in the resulting analysis. Involvement of personnel with an understanding of the MSHCP's take and mitigation projects is also recommended.

Collaboration and communication among partner agencies/entities and data sharing are highly recommended. This not only improves efficiency, it may well lead to collaborative interpretation and an overall streamlining of analytical procedures. Based on the experience of the CALFED Bay-Delta Program, the involvement of an independent panel in the process of assessing results is of utmost importance for the credibility of the program, and to provide the bigger picture and real world contexts which increase the chances of results being able to answer "so what?" questions which are frequently posed by stakeholders, the public and policy makers.

The CALFED Bay-Delta Program was used as an example for the framework document and August, 2008 workshop. The program seemed to be well-designed, with four primary objectives – water supply reliability, water quality, levee system integrity and ecosystem restoration, each of which had several associated performance measures. One of those for ecosystem restoration was the population status for Lange's Metalmark butterfly, which caused wry amusement among participants as a threshold of 2,000 had been selected, and workshop participants wondered how arbitrarily that originated! It was noted that the illustration of the conceptual model for the butterfly seemed overly busy and not particularly informative (www.calwater.ca.gov/science/pdf/monitoring/monitoring_phase_1_report_final_101707.pdf).

In the case of CALFED, the framework for performance measures identifies driver and outcome indicators, and prioritizes the latter. The results of priority 1 outcome indicators are the metrics upon which performance is evaluated, and relate to agency mandates or highest priority objectives. It is difficult and dangerous to arbitrarily set values for programmatic performance measures for which there is limited information. Establishing thresholds will inevitably be a "patchy" process, with some indicators being more advanced than others. The whole process takes time.

<u>Informing development of the Implementation Plan and Budgets</u>
Learning and hypothesis testing are integral to the whole process of PEM, which is unproductive unless there is a mechanism to effect change to "improve" indicator scores. In the case of the County's MSHCP, this is a two-year cycle initiated by development of an Implementation Plan and Budgets for the following biennium.

The collection of monitoring data, analysis and evaluation of indicator data, and decisions on what can and cannot be controlled and what might be done differently all contribute information to facilitate the "revise" sector of Figure 2. As a result of these evaluations, and new data which may have been generated in the ongoing biennium, priorities and goals are strategically adjusted and are reflected in the Implementation Plan and Budgets.

Requirements for a Programmatic Effectiveness Tracking System

Aside from the science-oriented requirements for PEM, there are operational aspects which will include a tracking system at programmatic level. The County's business objectives for the tracking system focus on key MSHCP questions such as:

- Are we in legal compliance with the permit?
- Are we making progress towards our measurable objectives and goals?
- Are active decisions (to change or maintain course) being made with the available data, information, reviews? (are the data that have been gathered being used effectively)
- Is it possible to improve our overall effectiveness and efficiency?

Questions such as these will help define the structure of the database, and are likely to be the search terms (with associated pull-down menu tabs) through which a user would derive initial information.

Two of the most important functional requirements for the tracking system are transparency, and that it is underpinned in a scientific and logical basis. As part of its activity as Science Advisor, DRI is in the process of developing two prototype databases – for MSHCP Implementation Status Tracking and Covered Species Population Trends respectively. A third database, for programmatic effectiveness tracking, should interface with these seamlessly in a synergistic way, making cross-referencing between them automatic. This would be done through common and linked search terms and data fields. Mitigation programs and activities involve the MSHCP staff in decision making, and are areas of the MSHCP in which the County has the ability to make changes. A system focus on generating actionable information is recommended.

Technical requirements include a user-friendly system, which should be built using software that is standard issue to the agency responsible for maintaining it. Clear and unequivocal metadata must be created. Summary output of the system should display on a page of the web, yet be clearly tied to the details of how it was generated and how recently is has been updated.

Recommendations

The advantages of forming partnerships and working in collaboration have been mentioned several times, and there are specific tasks which need to be completed before a programmatic effectiveness monitoring strategy is implemented, all of which would benefit from the collaborative approach.

Clear objectives for PEM for the MSHCP must be defined, and this could be accomplished by a small work group which would "report" to the larger stakeholder community. A similar method could be employed for the definition of indicators – for the MSHCP itself, and for non-MSHCP indicators targeting bigger picture information. Species, the program, and adaptive management may require individual indicators, depending on selection of metrics.

The process of indicator development and selection addresses the overall programmatic goal of "no net unmitigated loss". As stated elsewhere, conceptual models and well thought out hypotheses related to habitat and species assemblages are used to identify appropriate indicators. These indicators together with their integration (as indices) are used to reconcile this overall goal. Any thresholds applied to indicators and/or indices should grow out of the conceptual modeling process. These thresholds would be the most visible hypotheses in the program, but should be viewed as conditional just like other hypotheses. They should be tested and refined over time.

The August, 2008 workshop was a good start to collaborating on development of a PEM. Once goals, management-oriented conceptual models and critical uncertainties are developed and agreement has been reached on a strategy for implementing the monitoring there will be decisions to make concerning data quality assurance, data management and analysis, and reporting strategies. The process will be incomplete unless the adaptive management loop is completed by ensuring effective feedback to decision making, and empowerment of the personnel necessary for making changes.

References

Atkinson, A.J., P.C. Trenham, R.N. Fisher, S.A. Hathaway, B.S. Johnson, S.G. Torres and Y.C. Moore. 2004. Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans. U.S. Geological Survey. Western Ecological Research Center, Sacramento, CA. 69 p.

Clark County, 2002. Biennial Progress Report: 1999-2001 Biennium. Unpublished report to US Fish and Wildlife Service by Clark County. 131 p. plus appendices. Retrieved September 3, 2008 from http://www.accessclarkcounty.com/depts/daqem/epd/Pages/dcp_reports.aspx .

Clark County, 2004. Biennial Progress Report: 2001-2003 Biennium.. Unpublished report to US Fish and Wildlife Service by Clark County. 120 p. plus appendices. Retrieved September 3, 2008 from http://www.accessclarkcounty.com/depts/daqem/epd/Pages/dcp_reports.aspx .

Clark County, 2006a. Biennial Progress Report: 2003-2005 Biennium.. Unpublished report to US Fish and Wildlife Service by Clark County. 149 p. plus appendices. Retrieved September 3, 2008 from http://www.accessclarkcounty.com/depts/daqem/epd/Pages/dcp_reports.aspx .

Clark County, 2006b. Adaptive Management Report for the Clark County, Nevada Multiple Species Habitat Conservation Plan. Unpublished report to US Fish and Wildlife Service by Clark County. 116 p. plus appendices. Retrieved September 3, 2008 from http://www.accessclarkcounty.com/depts/daqem/epd/Pages/dcp_reports.aspx .

Clark County, 2008. Biennial Progress Report: 2005-2007 Biennium. Unpublished report to US Fish and Wildlife Service by Clark County. 224 p. plus glossary. In press.

Report accessed September 3, 2008. Will soon be available from http://www.accessclarkcounty.com/depts/daqem/epd/Pages/dcp_reports.aspx .

Karr, J. R. 2008. Indicators to assess ecological health. In S. E. Jorgensen, Editor. *Encyclopedia of Ecology.* Elsevier, San Diego, CA.

Mulder, B.S., B.R. Noon, T.A. Spies, M.G. Raphael, C.J. Palmer, A.R. Olsen, G.H. Reeves and H.H. Welsh. 1999. The strategy and design of the effectiveness monitoring program for the Northwest Forest Plan. General Technical Report PNW-GTR-437. Portland, OR. U.S. Department of Agriculture, Forest Service, pacific Northwest Research Station. 138 p.

omalley.3cdn.net/1857d3b7f96ee13e1f_02m6bhe5j.pdf (An article describing efforts to measure condition of Chesapeake Bay)

University of Nevada Reno, 2004. Clark County Desert Conservation Program Biennial Adaptive Management Report. Unpublished report to Clark County by University of Nevada Reno. 85 p. plus appendices. Retrieved September 3, 2008 from http://www.accessclarkcounty.com/depts/daqem/epd/Pages/dcp_reports.aspx .

Walters, C.J. 1986. Adaptive management of renewable resources. McMillan, New York.

Williams, B.K., R.C. Szaro and C.D. Shapiro. 2007. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC. 72 p.

www.calwater.ca.gov/science/pdf/monitoring/monitoring_phase_1_report_final_101707.pdf (CALFED Bay-Delta Performance Measures Report. 2007)

www.cvmshcp.org/Plan_Documents.htm (Coachella Valley MSHCP link to documents)

www.rctlma.org/mshcp/index.html (Western Riverside County Multiple Species Habitat Conservation Plan electronic version)

Appendix 1

Participants at August, 2008, Programmatic Effectiveness Monitoring workshop
The workshop was facilitated by Rob Sutter (The Nature Conservancy), and there were a total 23 participants, listed as follows in alphabetical order by last name:

Sharon Atkinson	City of Mesquite
Janet Bair	U.S. Fish and Wildlife Service
Cam Barrows	University of California, Riverside
Jodi Bechtel	Clark County
Julie Ervin-Holoubek	Nevada Department of Transportation
Michael Johnson	City of Henderson
Jim Karr	University of Washington (emeritus)
Jeri Krueger	US Fish and Wildlife Service
Judith Lancaster	Desert Research Institute
Dave Mouat	Desert Research Institute
Alice Newton	National Park Service
Brett Riddle	University of Nevada, Las Vegas
Carrie Ronning	Bureau of Land Management
Jan Schweitzer	City of North Las Vegas
Cheng Shih	City of Las Vegas
Casidee Shinn	UNLV student intern with NDOT
Stan Smith	University of Nevada, Las Vegas
Mark Stone	Desert Research Institute
Rob Sutter	The Nature Conservancy
John Tennert	Clark County
Scott Thomas	Desert Research Institute
Cris Tomlinson	Nevada Department of Wildlife
Sue Wainscott	Clark County