V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Sustainable Management of Natural Resources

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	10%		10%	
103	Management of Saline and Sodic Soils and Salinity	5%		5%	
121	Management of Range Resources	30%		30%	
123	Management and Sustainability of Forest Resources	10%		10%	
124	Urban Forestry	5%		5%	
135	Aquatic and Terrestrial Wildlife	10%		10%	
136	Conservation of Biological Diversity	5%		5%	
405	Drainage and Irrigation Systems and Facilities	10%		10%	
605	Natural Resource and Environmental Economics	15%		15%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	7.3	0.0	14.3	0.0
Actual Paid	2.6	0.0	15.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
427236	0	1330015	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
427236	0	1330015	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Researchers were able to show how five common desert toads relate to habitat and how future habitat changes might impact their populations. Furthermore, they laid groundwork in demonstrating how environmental factors influence detectability of desert anurans and how to best and most efficiently survey them

In terms of mitigation of climate change, a project using algae to produce biofuels has made huge advances. A review paper about modeling maximum lipid productivity of microalgae has achieved much attention in the international community. NMSU researchers further researched optimum environmental conditions (pH and nitrogen source) to economically cultivate Nannochloropsis salina.

Water used by agriculture is under intense scrutiny as supplies are tight and demand increases from non-agricultural sectors. Hydrologic research NMSU researchers are collaborating on builds understanding of how water diverted into community irrigation systems (acequias) of northern New Mexico can seep from ditches and percolate below fields and then reside in shallow groundwater for a time before returning to the river. This storage and release function provides water to the river in times of low flow and may actually save water on a regional basis by reducing evapotranspiration losses.

Population growth and development in the Southwest U.S. have increased the demand for water in the region. In some areas, due partly to recent droughts and excessive groundwater pumping, available water is insufficient to meet this demand. To conserve water for essential needs, many water districts have placed restrictions on water-use for irrigating food gardens and landscapes. If vegetable production and landscape quality are to be sustained in the region, efficient irrigation management techniques such as microirrigation and irrigation scheduling must be developed. NMSU researchers have identified water requirements and drip irrigation components for efficient irrigation management for production of vegetable crops and maintenenace of landscape plants, including plants that can be used in soil reclamation projects in the arid southwest. Microirrigation components for low pressure, water-saving situations, such as rainwater collection systems or where water is hauled to isolated sites, have also been identified. By using the recommendations resulting from this research, water will be conserved while plant production, landscape quality and soil stabilization may be sustained.

Providing research-based education that allows end-users to use less potable water and effectively use the limited water resources available in the arid southwest is paramount to sustainable living in the region. The results of experiments have provided a significant shift in understanding of the impact of fertilizers to

provide best management practices for turfgrasses grown in the arid southwest while reducing the overall turfgrass water requirements, and allowing desired ornamental residential landscapes with minimal impact to potable water supplies. Before this research, many landscape professionals believed additional fertilizer applications would increase the overall plant water use. However, these fertilizer applications allow plants to maintain acceptable quality with less water as compared to when no additional fertilizer is applied. End-users directly and indirectly touched by the research are making modest modifications in their cultural practices and switching to non-potable water sources for their landscapes.

An internet site that can be used to estimate ET for a crop has been developed. The internet site can estimate ET for any of the lower 48 U.S. states. All that is required from the farmer is crop type, acreage, planting date, and last irrigation date. Testing is continuing to determine any possible problems that may occur when the internet site is accessed and used. A spreadsheet program has been developed that will help farmers evaluate and track irrigation pump performance. This program requires that the farmer enter a minimal amount of data to estimate pump energy costs. These estimated costs can be compared to actual costs so that the farmer can track pump performance and determine if the pumping system is operating properly. This spread sheet has been presented at several irrigation workshops. Refinement of an initial design is being conducted on a simplified canal control gate. A design for a simplified overshot gate has been completed. Two irrigation districts have been given drawings and they are in the process of constructing and installing the gates. An open channel simulation algorithm has been completed to operate in Matlab. The algorithm solves the St. Venant open channel flow equations using a 4 point implicit solving method. This program has been expanded to model several reaches on a canal system. The program is being developed to test a ratio control program.

NMSU researchers identified plant taxa that can be used in greenroof ecosystems installed in arid environments, developed a method to classify urban landscapes, developed remote sensing techniques to detect drought early in pecans, and developed web interface to distribute information on landscape water conservation.

In arid and semi-arid regions where temperatures are warm and precipitation is low, organic matter decomposes rapidly and may have little effect on overall soil properties and soil quality. Research conducted on mine overburden demonstrated that adding 100 tons per acre of municipal biosolids had no effect on New Mexico Locust seedling establisment. Similarly, adding organic mulch to the overburden at rates of 2,000 pounds per acre did not enhance plant growth or establishment. Thus, rules about the addition of organic matter to soils developed in other regions may not be appropriate or suitable for the drier region of the southwestern U.S. Many soil quality indicators may improve with irrigation of saline waste water, however soil salinity and sodicity increase dramatically. Plants may be supported for a few years, but eventually the soil will degrade and need to be reclaimed using nonsaline water. Thus, not all soil quality indicators are equally critical in evaluating the productivity of a given soil. It appears that soil salinity and sodium adsorption ratio are the soil quality indicators most critical for arid and semi-arid regions

NMSU scientists are conducting research that is pertinent to the conservation and sustainable use of our natural resources. Large carnivore research will provide valuable information that state game agencies can use to manage their populations. Our work on examining the movements of golden eagles across North America will provide federal and state resource agencies with information necessary to plan renewable energy projects and mitigate potential impacts. Our work on the movement of rabies across the landscape can be used to evaluate strategies to minimize the spread of future outbreaks and our upcoming work on Department of Defense lands will contribute to finding solutions to reduce human-wildlife conflict.
A previous experimental study has generated considerable information on nitrate-nitrogen (NO_3-N) leaching in onion field under furrow fertigation in arid southern New Mexico. HYDRUS (2D/3D) model was

used to simulate spatial and temporal distributions of nitrate-nitrogen (NO3-N) within and below the onion root zone under conventional furrow fertigation with the urea-ammonium-nitrate liquid (UAN) fertilizer. The simulated water contents in the furrow irrigated onion field agreed well with the measurements. Simulations produced similar patterns of the measured NO3-N concentration profiles throughout the growing season. NO3-N concentrations remained higher and accumulation of NO3-N was observed within the root zone. Higher NO3-N within the root zone was dependent on the rate of the UAN fertilizer application, quantity of NO3-N removed by root uptake, and NO3-N drainage fluxes below the root zone. Simulations also suggested that NO3-N below the root zone during different growth stages remained much higher than a recommended (for drinking water) standard concentration level (10 mg $L^{\&minus1}$). This resulted in higher NO3-N drainage fluxes, particularly during the fertigation events between the establishment and vegetative growth stages. This indicates the need to apply most fertigation events at an early stage of bulb formation to provide the maximum NO3-N demands by onions and to reduce potential NO3-N leaching. The project results demonstrate that Hydrus 2D model can be used to model nitrate-N dynamics in the rootzone and below it and can be effectively used to reduce nitrate-N leaching through the soil profile. The results also demonstrated the usefulness of Fuzzy k-means classification on delineating contiguous areas for better management.

Two papers on the genetics of tadpole shrimp were published. The first paper described genetic structure between populations and found that the initial colonizers of an ephemeral pond strongly influence the genetic structure. There was an indication that migratory birds may facilitate colonization of ponds by crustaceans. The second paper used the complete mitochondrial DNA sequences to characterize the phylogenetic relationships between North American species of Triops and species from elsewhere in the world. Significant progress was made on goals 1 and 3, where a paper is in press in the Journal of Biogeography. That paper analyzes distribution and abundance of a freshwater mussel species that uses a fish host during its parasitic larval stage. The analyses show that biotic interactions with fish affect abundance of mussels over a spatial extent of up to 15 km. The analyses further showed that dams that limit fish movements in rivers have strong negative effects of mussel abundance.

Five New Mexico Meadow Jumping Mouse meetings/allotment visits and data collections were conducted at two different sites with analysis provided to allotment owners, and also assist two allotment owners with grazing management options to continue grazing and protect NMMJM habitat. Extension specialists provided comments on the proposed designated critical habitat and the Forest Service proposed action to improve mouse habitat.

Twenty-five percent of annual dairy permit reports submitted to NMED using NMSU's soil test interpretation workbook together with accurate documentation of land application demonstrate appropriate use of nutrients from all sources.

Twenty-five percent of clientele using NMSU's soil test interpretation workbook that are contacted report an improvement in plant production as a result of improved fertilizer source, time of application, rate of application or placement.
Fifty percent of New Mexico clientele who follow a nutrient management plan with adequate water can demonstrate maintained or improved crop production, reduced accumulations of nutrients, and improved use of nutrient sources.

Ninety-three percent of the 127 participants of the 2014 Master Gardener program in New Mexico considered training in turfgrass maintenance important and 92% of the participants reported that turfgrass training increased their knowledge of turf maintenance issues to either a great or a fair extent (immediately following a 3 hour training program). 57% of all 44 participants that have attended 3 or more years in the Master Gardener Program reported that repeated training in turfgrass maintenance has helped them

greatly in their career as a Master Gardener, and 96% reported that repeated training changed and enriched their understanding of turfgrass management differently than one time training would have. 71% admitted that repeated training changed their attitude towards turfgrass.

2. Brief description of the target audience

Target audiences include:ranchers, farmers, urban landscapers, park departments, state and federal agencies, private homeowners, and recreational users of parks, forests, and waters.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2014
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	3	76	79

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- The specific output measures will vary according to the specific project being monitored. The development of research procedures and technology, training of students, publishing research papers, and disseminating research results via educational workshops, conferences, and Extension media are important outputs for the various projects falling under this planned

program.

Year	Actual
2014	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	# of trained professionals
2	# of research publications
3	# of Extension publications
4	% of people adopting NMSU recommendations

Outcome #1

1. Outcome Measures

# of trained professionals

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	15

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
405	Drainage and Irrigation Systems and Facilities
605	Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

# of research publications

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	76

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
405	Drainage and Irrigation Systems and Facilities
605	Natural Resource and Environmental Economics

Outcome #3

1. Outcome Measures

# of Extension publications

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
405	Drainage and Irrigation Systems and Facilities
605	Natural Resource and Environmental Economics

Outcome #4

1. **Outcome Measures**

% of people adopting NMSU recommendations

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The majority of adult program evaluations carried out by New Mexico Extension agents and specialists are pre-post and post-program knowledge gain instruments. The majority of youth (primarily 4-H club) program evaluations are demonstrations of knowledge gained and applied in teaching others, competitive events, and climbing 'youth career ladders'. Rarely, if at any time, does an agent or specialist report that participant knowledge attained/gained was less than satisfactory. One can only assume that knowledge gain survey questions are fairly worded, and that audience participation was not mandatory. The only exception to this is with Master Gardener and Integrated Pest Management qualification exams. But again, participation is initially by application and the desire to learn and apply what is learned.

Key Items of Evaluation

What is interesting to note is that most Extension faculty now use goal setting, program objectives, and evaluation instruments in their program plans (as opposed to 10 years ago, when there was a great degree of resistance). The next step in program evaluation is to assist Extension agents and specialists to develop precision evaluation instruments. On-going training, such as the Western Extension Cohort (Evaluation) Training (WECT), needs to be organizationally supported and participation needs to be encouraged by all Extension faculty.

Also, the American Evaluation Association has an Extension group section and should become a legitimate and heavily encouraged professional Extension association. The Association does more than any other organization to encourage evaluation 'best practices.'