New Mexico State University
College Ranch and
Jornada Experimental Range:
A Summary of Research, 1900 — 1983
NEW MEXICO STATE UNIVERSITY COLLEGE RANCH AND JORNADA EXPERIMENTAL RANGE:

A SUMMARY OF RESEARCH, 1900 - 1983

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In 1982, the New Mexico State University College Ranch became the site of a Long Term Ecological Research (LTER) project, funded by the National Science Foundation. The interdisciplinary nature of the project and the potential for extensive cooperation with non-resident investigators illuminated a need for a comprehensive indexing of published research conducted at the College Ranch and the adjoining USDA Jornada Experimental Range. The resulting synthesis features a brief narrative history and outline of research, providing information for both technical and non-technical readers, and a bibliography and associated keyword-citation index designed as references in research pursuits. We thank the following individuals for assistance in identification and retrieval of pertinent literature and many helpful comments and suggestions:


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The New Mexico State University College Ranch is a 25,900 ha reserve created in 1927. The contiguous USDA Jornada Experimental Range was established in 1912, and consists of approximately 78,266 ha. Both the Jornada and the College Ranch have been administered for research since inception, fostering an extensive assemblage of scientific publications and reports. The Jornada has received additional formal recognition through scientific site designations, including Ecological Reserve (Institute of Ecology), Biosphere Reserve (UNESCO Man and the Biosphere Program), and Grassland Validation Site (U.S./International Biological Programme (IBP)/National Science Foundation (NSF)). The College Ranch was designated as a Desert Validation Site (U.S./IBP) and recently, as the Long Term Ecological Research Desert Site (NSF). These designations are associated with national and international research programs which have supported numerous projects in a broad spectrum of biological studies.

A history and general description of the Jornada area is presented in The Jornada Experimental Range by Fred N. Ares (21) and in The Jornada Experimental Range, Las Cruces, New Mexico, a bulletin of the USDA Science and Education Administration (191). Additional cultural data from the area is also available from 2 archaeological surveys conducted for seismic clearance, describing historic and prehistoric sites in the region.

The earliest research publications from the Jornada and College Ranch areas (1900-1950) include land form and water resource descriptions, plant species identifications, vegetative maps, and descriptions of major plant communities and soil-vegetation associations. Much of the habitat and character descriptions of semi-arid plant species appearing in Flora of New
Mexico by E. O. Wooten and P. C. Standley (460) were based on studies conducted in the region. An historic description of the origin of mesquite-sand dune areas associated with overgrazing and subsequent successional stages in grassland re-establishment appeared in 1929. Growth and life history characteristics of major range grasses (particularly black grama and tobosa) were investigated in conjunction with range management activities. With the exception of a species listing for amphibians and reptiles of the area, no zoological studies were published during this time. A major segment of research during this early period emphasized range management, including stocking levels and systems, nutritive value of range forage, nutrient status of cattle, effects of nutrient and roughage supplementation, identification and control of range plants toxic to livestock, and water spreading and retaining techniques. Eradication of mesquite and associated grass seeding techniques were initiated during this time. Animal science investigators examined other features of livestock management, such as bull selection, peak productivity ages of cows, and importance of body type, size, and sex of cattle in determining range and feedlot performance. Many of the publications resulting from these studies appeared as agricultural bulletins and popular articles offering information and directives for improved ranching success on semi-arid rangelands. More detailed reviews of early range and animal science investigations have been presented in Research on the College Ranch by J. H. Knox, W. E. Watkins, M. Koger, and K. A. Valentine (215) as well as in the previously cited bulletins on the Jornada Experimental Range. Soil and associated vegetative sample data for the area are available from an original Land Office Survey of 1858, and subsequent surveys of 1915, 1928, and 1963. An initial study of soil strata was conducted by J. O. Veatch in 1918 (unpublished report), followed by detailed soil strata analyses carried
out in the 1930's. Rainfall records for the Jornada Experimental Range headquarters have been maintained since 1914, and at other locations since the 1930's.

During 1950-1970, several notable botanical studies appeared, including a detailed life history description for creosotebush, and vegetative community analyses identifying the historical background of succession on various soil types and influences of land use practices in producing the current species assemblages. Experiments conducted with grass and shrub seeds revealed the inhibitory effects of aqueous extracts of creosotebush material on germination; additional studies demonstrated germination response to varied temperature and moisture regimes. The range management emphasis on brush control was expanded to include experiments with mechanical and chemical control of mesquite, creosotebush, and tarbush, with associated grass seeding efforts. These studies demonstrated costs and innovative techniques for improvement of range for livestock use. Detailed chemical analyses of many range grasses and forbs documented marked seasonal variations in nutrient content. Grazing distribution, behavior, and forage selection by cattle of various breeds were also addressed as aspects of range management. Heritability of economically valuable traits and certain genetic defects in Hereford cattle was described from analyses of the detailed records for research herds at the College Ranch and at New Mexico Agricultural Experiment Station sites. A series of soils studies were published in 1961-1979 which described distinctive features of the soil profile of the region, emphasizing the nature and origin of a carbonate-impregnated horizon. Geomorphology of the Jornada del Muerto basin and stratigraphy of surrounding mountains were also described during this period. Entomological research focused on insect species occurring on range grasses. In addition to life history and food
habits studies of several vertebrate species, a series of publications were produced describing the composition and distribution of rodent communities, their role in range conditions and their response to rodenticide treatments.

Since 1970, numerous plant studies have focused on adaptive specializations in physiology, morphology, and reproductive strategies in desert species. Much of the recent botanical research was conducted in association with the U.S./IBP programs. Creosotebush received extensive attention, through investigations of soil-water relationships, primary productivity, tissue-water movements, leaf senescence, and shrub-grass associations. Major studies of photosynthesis and growth and reproduction in yucca were conducted. Increased emphasis on experimental research involved manipulative studies of grass and shrub responses to moisture and nutrient amendments, chemical pesticide and herbicide applications, and varying grazing and harvesting systems. Animal science investigators have identified factors influencing milk production, calving interval, postweaning growth, feedlot and carcass performance, and reproduction in Brangus, Hereford and crossbred cattle utilizing semi-arid rangelands. In addition to grazing manipulation studies, range scientists have analyzed seasonal variation in range plant availability and utilization by livestock and described overall primary productivity of the grassland ecosystem. Brush and toxic plant control experiments continue, including assessment of shrub use by goats, and identification of insect species which attack noxious plants. Several authors have published analyses of long-term vegetative data from the Jornada, describing the interaction of climate, land use practices, soil movement, and plant community succession, in producing the mesquite dunelands which are widespread in the region. Factors in the nature and progression of desertification including soil erosion, grassland composition, and caliche formation are currently under study by several investigators.
A major soil-vegetation study published in 1973 portrays the relationship of plant growth to soil texture and topography, as features determining soil moisture availability. This paper includes a notable discussion of the function of the caliche layer as a barrier to moisture loss, maintaining long-term moisture availability to plants during dry seasons. Relative proportions of calcium, magnesium, and organic carbon in various soil horizons have also been examined. The Desert Project Soil Monograph (131), published in 1979, and a 1980 soil survey of Dona Ana County (43) summarize the nature and extent of local soil formations. These analyses of soil structure and composition are complemented by recent studies of soil microbiology identifying soil microfauna components, soil respiration, microbial activities in protein degradation, and variations in microbial activity in response to herbicide contamination.

Zoological research has received increasing attention, fostered in part through funds from the U.S./IBP program. The body of data collected during the U.S./IBP projects and subsequent extensions of some of those studies have produced a wide array of publications. Among these are a series of papers on thermal physiology, foraging activities, distributions, and population interactions of several ant species. Another segment of recent research has focused on characterization of decomposition rates and associated nutrient cycling in desert soils, including identification of soil fauna communities and their role in decomposition. Descriptions of density and diversity in lizard, rodent, and bird communities in several diverse habitats were generated through the U.S./IBP program. More recently, data on rodent, arthropod, and bird communities in mesquite-sand dune habitats of the Jornada were collected in association with a USDA/SEA brush control project. Detailed environmental data, including precipitation, temperature, humidity, radiation, and soil temperature and moisture content were also collected during most of these more recent projects.
Numerous studies of individual vertebrate species have been conducted since 1970. These include thermal physiology and water balance experiments (reptiles and amphibians), behavioral observations (lizards, birds, and mammals), food habit analyses (birds, rodents, rabbits, and pronghorn), and competitive interaction investigations (rodents and birds). As noted earlier in relation to botanical research, much of the recent zoological work has also emphasized an experimental approach, involving manipulative field studies, often supplemented with laboratory observations. Many of these studies have incorporated analyses of the effects of various range management practices (chemical and mechanical brush control, use of insecticides, and grazing allotments) on various animal groups (e.g. ants, birds, rodents), as well as on individual species. The pervasive topic addressed in current research is identification of the patterns and mechanisms of organism response to environmental variables, and the adaptive nature of those responses relative to the environmental parameters unique to a desert ecosystem.

Funding from the U.S. Department of Agriculture, National Science Foundation, New Mexico Agricultural Experiment Station, New Mexico State University and numerous other public and private agencies has provided the strong, continuing support necessary to generate this extensive scientific record. The past and present investigators participating in research on the Jornada Experimental Range and the College Ranch include representatives from many disciplines at New Mexico State University, as well as visiting scientists from the United States, Mexico, and abroad. Over 100 theses and dissertations involving research at the Jornada and the College Ranch have been produced since 1956, most of which have later appeared in scientific journals.
RESEARCH TOPICS

The following outline summarizes major topics of research conducted at the New Mexico State University College Ranch and the USDA Jornada Experimental Range. The outline is organized by discipline (zoology, animal science, etc.) and progresses from intensive single species studies to more general subjects encompassing community interactions and processes, and research and management techniques within each discipline. Many topic categories include research from several disciplines (i.e. germination experiments have been conducted in botany, range science, and agronomy) and are arbitrarily assigned a position in the outline.

I. Botany

A. Single Species/Taxon

1. **Yucca elata, Y. baccata** (Liliaceae) - yucca
   a. leaf photosynthesis.
   b. morphology.
   c. growth and reproduction.

2. **Bouteloua eriopoda** (Gramineae) - black grama: growth and reproductive characteristics and response to grazing and drought.

3. **Panicum obtusum** (Gramineae) - vine mesquite
   a. biomass variation.
   b. response to grazing.

4. **Atriplex canescens** (Chenopodiaceae) - fourwing saltbush: reproduction.

5. **Prosopis glandulosa** (Mimosoideae) - mesquite: size variation and density.
6. *Larrea tridentata* (Zygophyllaceae) - creosotebush
   a. life history.
   b. leaf senescence.
   c. tissue water movements.
   d. allocation of vegetative versus reproductive effort associated with moisture amendment.
   e. response to water stress associated with soil depth.
   f. primary production and carbon allocation.
   g. presence of nordihydroguaiaretic acid.
   h. association with bush muhly.

7. *Sphaeralcea coccinea*, *S. grossulaerifolia*, *S. munroana* (Malvaceae) - globemallow: germination.

8. *Chilopsis linearis* (Bignoniaceae) - desert willow: vegetative versus reproductive allocations.

9. *Xanthocephalum sarothrae* (Compositae) - snakeweed: biomass variation.


11. Gramineae: stem morphology; germination and seed characteristics.


B. Plant Communities
1. Plant community classifications, species listings, and succession associated with soil types.
2. Relationships of plants to soil types and soil water-potentials.


5. Photosynthetic rate/leaf resistance associated with leaf morphology.

6. Responses to nitrogen amendment, insecticides, herbicides, drought, and defoliation.

7. Plant growth models.

8. Grass and forb demography.


10. Short-term water and energy flow.

11. Temporal variation in grassland community structure and productivity, associated with presence or absence of grazing.


C. Germination

1. Germination characteristics of specific grasses, forbs and shrubs.

2. Germination/emergence rates from random soil samples.

3. Inhibition of grass germination by aqueous extracts of snakeweed and creosotebush.

4. Germination and transplantation of desert species for use as ornamentals.

D. Techniques

Point series sampling, pace transect, belt transects, dry weight estimation, computer chart quadrat interpretation, and photointerpretation.
II. Zoology

A. Single Species/Taxon - Diplopoda: Orthoporus ornatus millipede: life history and physiology.

B. Single Species/Taxon - Insecta

1. Chirothrips falsus (Thysanoptera: Thripidae) - thrip: life history and control on grass.

2. Microphorus carolinus (Coleoptera: Silphidae) - burying beetle: feeding behavior.


4. Novomessor cockerelli, (Hymenoptera: Formicidae)
   a. dessication.
   b. foraging.


   a. densities.
   b. foraging and territoriality.
   c. seed selection.
   d. response to predation.
   e. dessication.


10. *Tegeticula yuccasella* (Lepidoptera: Incurvariidae) - yucca moth: specificity to *Yucca* spp.


C. Insect Communities

1. Soil microarthropods and decomposition
   a. termites: litter colonization and location; role in decomposition, nutrient cycling and soil physics.
   b. microarthropods and other decomposers: density and diversity associated with moisture amendment, inhibitors, and litter distribution; decomposition rates.

2. Effects of girdling and boring insects (Bostrichidae) on mesquite.

3. Variations in ant density and diversity associated with habitat, vegetation, soil type; effects of herbicides; desiccation rates.

4. Insect species associated with range grasses.

D. Single Species/Taxon - Reptilia and Amphibia


3. *Phrynosoma cornutum, P. douglassi* (Iguanidae) - horned lizard
   a. water balance and thermoregulation.
   b. feeding behavior.
4. *Urosaurus ornatus* (Iguanidae) - tree lizard: behavior.

**E. Amphibian and Reptile Communities**

1. Species list.

2. Density and diversity in lizard communities and anuran communities associated with environmental variables.

**F. Single Species/Taxon - Aves**


2. *Lophortyx gambelii* and *Callipepla squamata* (Galliformes: Phasianidae) - Gambel's quail and scaled quail: physiology.

3. *Athene cunicularia* (Strigiformes: Strigidae) - burrowing owl: habitat, food and reproduction.

4. *Chordeiles minor*, *C. acutipennis* (Caprimulgiformes: Caprimulgidae) - nighthawk: competition in 2 species.


**G. Bird Communities**

1. Density and diversity; structure.

2. Species list.

3. Mobbing behavior.

4. Response to chemical brush control

**H. Single Species/Taxon - Mammalia**

1. *Dipodomys spectabilis*, *D. merrami*, *D. ordii* (Rodentia: Heteromyiidae) - kangaroo rat
   a. reproduction.
   b. burrow environment.
c. physiology.
d. response to brush control.
e. food habits.
f. effect on grassland community.

2. *Chaetodipus intermedius, C. penicillatus* (Rodentia: Heteromyidae) - pocket mouse: habitat, physiology, behavior.


I. Mammalian Communities: Rodentia

1. Composition, changes in density and diversity associated with precipitation, vegetation, and rodenticides.

2. Habitat selection.

III. Soil Microbiology

A. Survey of aerobic spore-forming bacteria.

B. Microbial degradation of protein amendments.

C. Microbial response to herbicide treatments.

D. Soil respiration rates.

IV. Range and Animal Sciences

A. General

1. Growth and germination characteristics of grass species; responses to various grazing systems.
2. Use of non-grass plants for supplemental livestock feed.
3. Determination of plant volume for stocking level.
4. Grass responses to defoliation, fertilization, and burning.
5. Plant species utilized by cattle; nutritive value, composition and availability of forage species.
6. Water retention structures to increase available soil moisture.
7. Generalized plans for rangeland management; modeling of grazing management systems.

B. Control of Brush and Toxic Plants
   1. Growth characteristics, distribution, toxicity, and associated management directives for toxic plants.
   2. History of invasion of brush and weed species and associated management practices.
   3. Techniques and effectiveness of chemical and mechanical control measures for creosotebush, mesquite and tarbush.
   4. Techniques and effectiveness of environmental modification and grass reseeding following brush eradication.

C. Livestock Management
   1. Performance of Hereford, Brangus, Santa Gertrudis, and cross-bred cattle on semidesert ranges.
      a. milk production.
      b. calving interval.
      c. reproductive output.
      d. postweaning growth.
      e. feedlot performance.
      f. carcass quality.
   2. Genetic defects in Hereford cattle; genetic selection systems in cattle breeding.
3. Livestock behavior.
   a. forage selection and use efficiency.
   b. activity patterns associated with water, salt, and seasonally varying forage distribution.

4. Cattle nutrition and associated blood biochemistry.
   a. seasonal nutrient status for protein, phosphorus, calcium and vitamin A.
   b. seasonal micronutrient status.
   c. effects of nutrient supplementation.
   d. digestibility of various forage plants.

V. Abiotic

A. General-geographical maps, soil maps, climate data.

B. Geology
   1. Geomorphology and hydrology of Jornada del Muerto basin.
   2. Stratigraphy of surrounding mountains.
   3. Quarternary origins of current geologic formations.

C. Soils
   1. Relationship of soil moisture to precipitation, soil profile, and landscape position.
   2. Soil composition and moisture characteristics associated with various vegetative communities.
   3. Correlations between organic carbon and \(\text{CO}_3\) Mg, and Ca.
   4. Description and origin of carbonate impregnated k-horizon; morphology of argillis horizon.
   5. Relationship of soil development to horizon age.
VI. Historical

A. Prehistoric and historic sites on seismic clearance transects.
B. Historical narratives for the Jornada and College Ranch.
C. Reports of early (pre-1900) exploratory expeditions in area.

VIII. IBP Research

Much information contained in the various IBP reports has been published and is described in the appropriate topic section. Many of the technical reports are available only through individual authors.

A. Desert Site

1. Annual reviews of research.
2. Individual reports on arthropods, decomposition, meteorological data, plant distributions, productivity and phenology, and seed germination potentials.
3. Reports integrating data from all IBP Desert Sites and synthesizing generalized models for desert ecosystem dynamics.

B. Grassland Site

1. Annual reviews of research.
2. Individual reports on primary production, arthropod, rodent, and bird communities, and decomposition.
3. Reports integrating data from all IBP Grassland Sites and synthesizing generalized models for grassland ecosystem dynamics.
KEYWORD LIST

The following set of keywords have been used to identify the major features of each citation. A computerized bibliographic search program is employed to retrieve and display citations associated with a given set of keywords.

A current citation index and the keyword searching programs are maintained on computer files at the Long Term Ecological Research Data Management Office at New Mexico State University. A supporting reprint collection is also maintained for reference use by interested investigators.

| AMPHIBIAN   | COMMUNITY   |
| ARCHAEOLOGY | CREOSOTE    |
| ARTHROPODA  | DECOMPOSITION |
| ARTIODACTYLA| DEMOGRAPHIC  |
| AVES        | DESERT      |
| BEHAVIOR    | DISEASES    |
| BIOCHEMICAL | DISSERTATION |
| BIOMASS     | DISTRIBUTION |
| BLOOD       | DROUGHT     |
| BOOK        | (BIO) ENERGETICS |
| BRUSH-CONTROL| EVAPOTRANSPIRATION |
| BRYOPHYTA   | FERTILIZERS |
| CARBON      | FLORAL      |
| CARBON-DIOXIDE | FOOD HABITS |
| CARNIVORA   | FUNGI       |
| CATTLE      | GENETICS    |
The following summary gives the identification numbers (from the appended bibliography) of all citations associated with each keyword.

**AMPHIBIAN**
74 94 95 96 233 251 380 423 425

**ARCHAEOLOGY**
102 398

**ARTHROPODA**

**ARTIODACTYLA**
110 126 134 184

**AVES**
30 44 45 77 91 93 234 241 292 294 299 300 307 379 442 443

**BEHAVIOR**
30 67 92 93 140 164 171 183 189 204 253 263 335 340 348 379 399 402 413 415 416 417 420 429 432 435

**BIOCHEMICAL**
34 146 200 211 213 264 265 266 285 298 343 354 377 383 384 389 454

**BIOMASS**
5 25 107 113 119 179 205 259 260 261 290 334 363

**BLOOD**
213 264 267 298 308 387 390

**BOOK**
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DISEASES
28 31 32 46 143
DISSERTATION
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Fungi

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GENETICS

| 28 | 31 | 32 | 33 | 220 | 245 | 319 | 337 |

GEOLOGICAL

| 87 | 88 | 123 | 127 | 129 | 131 | 145 | 161 | 178 | 197 | 201 | 222 | 324 | 341 |

(BLACK)-GRAMA

| 27 | 35 | 37 | 38 | 47 | 52 | 53 | 54 | 56 | 60 | 61 | 62 | 63 | 69 | 101 | 122 | 123 | 135 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
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| 270 | 286 | 287 | 288 | 293 | 350 | 351 | 354 | 373 | 374 | 383 | 384 | 386 | 388 | 389 | 391 | 392 | 447 |
| 467 | 468 | 469 | 470 |

GERMINATION

| 3 | 124 | 125 | 137 | 169 | 188 | 206 | 207 | 208 | 231 | 262 | 306 | 323 | 350 | 351 |

GRASSLAND

<p>| 2 | 3 | 5 | 10 | 35 | 36 | 37 | 38 | 51 | 53 | 54 | 56 | 60 | 61 | 62 | 63 | 66 | 69 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
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| HERBICIDE        | 154 | 159 | 162 | 174 | 177 | 231 | 275 | 326 | 375 | 436 | 450 | 451 |

| HISTORY          | 6   | 7   | 21  | 41  | 42  | 102 | 123 | 154 | 190 | 191 | 232 | 244 | 286 | 398 |

| HYDROLOGIC       | 22  | 24  | 26  | 43  | 105 | 161 | 197 | 201 | 324 | 362 |

| INSECT           | 67  | 105 | 107 | 111 | 112 | 117 | 118 | 189 | 192 | 193 | 194 | 202 | 203 | 204 | 241 | 252 | 284 | 315 |
|                  | 328 | 331 | 333 | 334 | 335 | 336 | 339 | 340 | 347 | 348 | 349 | 391 | 392 | 393 | 402 | 403 | 404 | 406 |
|                  | 407 | 411 | 413 | 414 | 415 | 416 | 417 | 419 | 420 | 424 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 434 |
|                  | 435 | 439 | 450 | 451 |

| JORNADA-EXP.-RANGE | 1   | 2   | 4   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
|                    | 21  | 24  | 29  | 35  | 36  | 37  | 40  | 41  | 42  | 43  | 44  | 45  | 47  | 48  | 49  | 50  | 51  | 52  |
|                    | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  | 61  | 62  | 63  | 66  | 67  | 69  | 78  | 87  | 88  | 90  |
|                    | 101 | 102 | 107 | 108 | 109 | 110 | 114 | 115 | 116 | 118 | 119 | 120 | 126 | 127 | 129 | 131 | 134 | 138 |
|                    | 139 | 140 | 144 | 145 | 146 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
|                    | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 |
|                    | 179 | 180 | 181 | 184 | 186 | 187 | 190 | 191 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 206 | 207 |
|                    | 208 | 221 | 222 | 224 | 228 | 229 | 230 | 231 | 232 | 233 | 235 | 236 | 244 | 246 | 247 | 249 | 250 | 253 |
|                    | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 272 | 273 | 279 | 280 | 281 | 286 | 287 | 288 | 289 | 290 |
|                    | 291 | 292 | 293 | 294 | 298 | 299 | 300 | 303 | 307 | 309 | 310 | 315 | 316 | 317 | 318 | 324 | 325 | 326 |
|                    | 341 | 342 | 343 | 350 | 351 | 364 | 366 | 367 | 368 | 370 | 371 | 372 | 373 | 375 | 378 | 385 | 394 | 395 |

27
LAGOMORPHA
85 86 221 274 356

LIST
43 175 190 230 232 233 249 299 300 363 391 393 394 460

LITTER
106 117 241 328 329 330 331 332 357 369 424 438 439 440

MANAGEMENT
1 3 8 9 10 11 12 13 14 15 16 18 19 20 21 27 29 33
38 39 42 47 49 50 52 53 54 56 57 58 62 63 65 68 69 76
78 89 98 114 115 116 146 147 151 152 153 155 156 162 163 164 165 166
167 169 170 171 173 174 175 176 177 180 186 187 199 202 206 207 209 210
212 214 215 216 217 218 219 220 221 224 225 226 231 235 237 245 247 254
255 256 258 259 261 265 266 267 268 269 270 271 272 273 275 278 281 282
283 286 287 288 293 295 301 302 314 319 320 321 322 325 337 338 358 364
365 367 368 371 372 373 374 375 382 383 384 385 387 388 389 392 395 445
446 447 448 449 453 457 458 470

MASTERS-THESIS
3 22 23 24 25 29 30 41 46 64 65 68 76 77 89 92 97 98
99 101 104 107 110 122 124 126 134 135 140 143 147 148 179 180 181 185
188 198 208 221 223 227 236 237 245 248 251 252 253 257 259 260 262 271
277 280 295 296 298 304 306 307 314 318 319 320 323 325 326 327 333 337
338 339 343 344 347 350 354 358 364 365 378 379 396 444 448 450 454 461
462 464 470

MESQUITE
35 41 47 138 148 149 150 162 170 174 177 262 275 282 426 430 464 465
467 469
<p>| METABOLISM       | 60  61  101  123  135  136  164  175  176  206  207  208  232  254  256  350  351  384  389  396  397 |
| METEOROLOGICAL   | 70  71  72  73  94  104  111  193  195  251  326  344  348  454  461 |
| MICROBIAL       | 142 276 285 326 332 454 |
| MODEL           | 1  36  80  81  82  205  280  294  311  312  313  325  440 |
| MORPHOLOGICAL   | 46  48  58  60  61  88  128  129  130  132  133  161  222  239  254 |
| (BUSH)-MUHLY    | 60  61  101  123  135  136  164  175  176  206  207  208  232  254  256  350  351  384  389  396  397 |
| NESTBOXES       | 77  93  347  349 |</p>
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**POPULAR-ARTICLE**

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**PRECIPITATION**

| 40 | 236 | 241 | 250 | 287 | 303 | 325 | 447 |

**PREDATION**

| 339 | 340 | 379 | 417 |

**PRODUCTIVITY**

| 10 | 65 | 68 | 76 | 80 | 83 | 84 | 89 | 90 | 140 | 151 | 167 | 218 | 228 | 238 | 240 | 241 | 245 |
| 254 | 255 | 256 | 260 | 261 | 267 | 271 | 277 | 280 | 287 | 289 | 301 | 302 | 311 | 319 | 337 | 338 | 342 |
| 358 | 360 | 374 | 397 | 405 | 426 | 441 | 448 | 449 | 470 |

**PROTEIN**

| 265 | 322 | 386 |

**RANGELAND**

| 1 | 3 | 8 | 9 | 10 | 12 | 13 | 15 | 16 | 19 | 21 | 27 | 38 | 39 | 42 | 47 | 49 | 50 |
| 54 | 56 | 61 | 63 | 69 | 78 | 86 | 89 | 90 | 147 | 152 | 153 | 154 | 155 | 156 | 162 | 163 | 164 |
| 165 | 166 | 167 | 170 | 171 | 173 | 174 | 175 | 176 | 186 | 187 | 191 | 206 | 207 | 215 | 221 | 224 | 231 |
| 235 | 236 | 238 | 247 | 254 | 255 | 256 | 257 | 258 | 259 | 261 | 263 | 265 | 266 | 268 | 269 | 270 | 273 |
| 275 | 281 | 282 | 283 | 286 | 287 | 288 | 293 | 295 | 301 | 302 | 320 | 321 | 322 | 325 | 358 | 364 | 366 |
| 367 | 368 | 371 | 373 | 374 | 382 | 383 | 384 | 385 | 386 | 388 | 389 | 391 | 392 | 393 | 445 | 449 | 453 |
| 457 | 458 | 470 |
SOIL

22 24 25 26 42 43 55 79 88 105 112 127 128 129 130 131 132 133
137 138 142 145 148 149 161 172 173 176 185 191 201 222 249 276 277 285
309 312 324 326 328 329 330 332 334 343 354 355 362 366 377 424 433 439
454 467

SUCCESSION

41 47 54 148 150 172 286 465

SURVIVAL

306

TOBOSA

10 51 60 61 62 63 69 103 123 135 136 151 155 164 165 175 198 199
206 207 232 277 286 287 288 350 351 364 373 384

TECHNICAL-BULLETIN

27 34 35 37 39 40 43 56 63 66 73 83 86 87 88 90 102 103
108 109 114 115 116 119 120 125 127 129 131 136 137 139 144 145 146 154
155 156 159 162 163 166 167 168 173 174 175 178 184 186 187 190 191 197
201 205 210 211 212 213 214 215 222 224 225 226 228 229 239 243 244 246
247 249 250 263 264 265 266 267 268 270 272 273 274 275 276 279 282 287
288 289 290 291 292 299 301 302 303 308 309 310 316 317 324 341 342 352
353 371 374 375 376 382 384 389 390 392 394 398 400 401 402 403 404 405
406 407 408 409 410 411 419 421 428 430 431 433 441 442 445 447 449 453
455 456 457 458 459

TECHNIQUE

2 23 78 170 293 295 362 370 378 466

TEMPERATURE

303 421 433

THALLOPHYTA

232 243
THERMAL-REGULATION
95 96 192 193 194 296 297 422

TOXICITY
13 20 175 188 224 231 235 261 281 283 452

TROPHIC
109

US-IBP
66 73 83 108 109 119 120 137 139 144 168 205 228 229 243 246 276 279
289 291 292 303 309 310 316 317 342 352 353 394 400 401 402 403 404 405
406 407 408 409 410 411 419 421 428 430 431 433 441 442

VERTEBRATA
4 30 36 44 45 74 75 77 85 92 93 94 95 96 104 110 121 126
134 139 141 144 182 183 184 195 196 221 223 233 251 253 257 279 292 294
296 297 300 304 305 307 318 339 340 356 357 379 380 399 411 412 417 418
422 423 425 442 443 452 453 462 463

YUCCA
39 48 57 58 116 252 321 344 345 346 381


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