

**ORGAN PIPE CACTUS NATIONAL MONUMENT
RESEARCH**

Project Title: Tumamoc Globe-berry Studies in Arizona and Sonora, Mexico

Principal Investigator: Frank W. Reichenbacher

Project Start Date: 1988

Project End Date: 19

CORRESPONDENCE

12/05/89	From:	Harold J. Smith, Supt., ORPI
	To:	Frank W. Reichenbacher
	Subject:	Request for Investigators Annual Report for 1989
12/19/88	From:	Harold J. Smith, Supt., ORPI
	To:	Frank W. Reichenbacher
	Subject:	Request for Investigators Report for 1987

PROPOSAL

Tumamoc Globe-berry Studies in Arizona and Sonora, Mexico

Principal Investigator: Frank W. Reichenbacher, F.W. Reichenbacher & Associates, Tucson, Arizona

CERTIFICATION/CONTRACT

unsigned

Tracking Sheet for Research Projects

FINANCIAL DOCUMENTATION

PERMITS

INVESTIGATOR'S ANNUAL REPORT

1989 - Annual Investigator's Report - submitted by Frank W. Reichenbacher

FINAL REPORT

OTHER REPORTS

DATABASE

OTHER

N22

December 5, 1989

Mr. Frank W. Reichenbacher
F.W. Reichenbacher & Associates
2739 North La Cienega Drive
Tucson, AZ 85715-3530

Dear Mr. Reichenbacher:

Enclosed is a copy of the Investigators Annual Report for calendar year 1989. We are asking that each principal investigator conducting research within the park complete and return this form to us no later than January 10, 1990. This report should be filled out by those who are now working on a project(s) or who may have completed field work and are in the report writing phase. If you are working on more than one project, fill out one form for each. Confine your responses to the spaces provided.

This report must be received by the park before authorization will be granted to continue research into 1990.

We appreciate your cooperation with this request and thank you for your efforts in bringing a greater base of knowledge about the resources of Organ Pipe Cactus National Monument.

For those of you have filled out Investigators Annual Reports in the past, you will note that this year's format is somewhat different. The structure of the report has been standardized throughout the Park Service to facilitate the gathering of data nationwide. If you have any questions please contact Jim Barnett at (602) 387-6849.

From the staff at Organ Pipe Cactus we wish you the best during this holiday season.

Sincerely yours,

Harold J. Smith
Superintendent

encl.

N22

December 19, 1988

Mr. Frank W. Reichenbacher
F. W. Reichenbacher and Associates
2739 North La Cienega Drive
Tucson, Arizona 85715

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Sincerely yours,

Harold J. Smith
Superintendent

TECHNICAL PROPOSAL

TUMAMOC GLOBE-BERRY STUDIES IN
ARIZONA AND SONORA, MEXICO

Request for Proposal No.:

8-SP-32-00340

May 16, 1988

Submitted by:

Frank W. Reichenbacher
F.W. Reichenbacher & Associates
2739 North La Cienega Drive
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Presented to:

U.S. Bureau of Reclamation
Arizona Projects Office
23636 North 7th Street
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STATEMENT BY AUTHOR

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Signed

F.W. Reichenbacher

Date

9/13/88

Title

Colonel

TABLE OF CONTENTS

	Page
I. RESEARCH DESIGN	5
A. Taxonomy and Description of Tumamoc Globe-berry	6
B. Habitat and Distribution	7
C. History and Background of Study	9
D. Statement of Research Goals and Objectives	11
E. First Year Studies - Range Delineation	12
1. Stratification by Substrate and Local Environment . .	13
2. Stratification by Key Climatological Characteristics	13
3. Sampling Methods	21
F. Second Year Studies - Population Density Studies	25
1. Study Site Selection	25
2. Sampling Method and Procedure	26
G. Determining Voucher Specimen Needs	28
H. Data Analysis	29
I. Literature Cited	30
II. PLAN OF WORK	32
A. First-Year Studies	33
1. University of Sonora Cooperative Agreement	34
2. Assemble and Instruct Sonora and Arizona Field Crews	34
3. Determine Study Area and Locate Transect Sites . . .	35
a. Stratify Study Area by Substrate and Local	
Environment	36
b. Stratify Study Area by Key Climatological	
Characteristics	36
c. Determine Transect Locations	36
4. Obtain Access Permission and Collecting Permits . . .	37
a. Federal Endangered Species Collecting Permit . .	37
b. U.S. Bureau of Land Management Lands	37
c. National Park Service Lands	37
d. Gila River Indian Reservation	38
e. Tohono O'odham Nation	38
f. Arizona State Trust Lands	39
g. Mexico Permits	39
5. Assign Weekly Survey Tasks	39
6. Conduct Field Studies	39
a. Select Transect Coordinates and Orientation . .	40
b. Walk Transect	40
7. Field Crew Management - Sonora Studies	41
8. Field Crew Management - Arizona Studies	41
9. Voucher Specimen Collection and Curation - Sonora	
Studies	42

	Page
10. Voucher Specimen Collection and Curation - Arizona Studies	42
11. Data Analysis - First-Year Studies	42
B. Second-Year Studies	43
1. Determine Study Sites	44
2. Assemble and Instruct Field Crews	44
3. Obtain Access Permission	44
4. Assign Weekly Survey Tasks	45
5. Conduct Field Studies	45
a. Locate Quadrat Sites	45
b. Mark Quadrat Boundaries	46
c. Survey Quadrat	46
6. Field Crew Management	46
7. Data Analysis - First-Year Studies	47
C. Final Deliverables	47
1. Maps	48
2. Reports	48
3. Additional Deliverable Items	49
D. Project Schedule	49
E. Safety Plan	49
III. PROFESSIONAL QUALIFICATIONS	51
A. Resumes of Key Personnel	57
IV. ORGANIZATIONAL QUALIFICATIONS	69
A. List of Clients and Contracts	70
B. Reports Under Contract	72

LIST OF TABLES

	Page
Table 1. Maxima and minima of critical climatological variables for weather stations representing known <u>T. macdougallii</u> populations	14
Table 2. Climatological characteristics of selected locations in Arizona and Sonora	15
Table 3. Proposed Project Completion Schedule	50

LIST OF FIGURES

	<u>Page</u>
Figure 1. Range and distribution of <u>Tumamoca macdougallii</u> and distribution of 46 weather stations	17
Figure 2. Principle components ordination of 46 weather stations in Arizona and Sonora	18

I. RESEARCH DESIGN

In RFP 8-SP-32-00340 the U.S. Bureau of Reclamation (BOR) announced its desire to fund a study of the Tumamoc globe-berry (Tumamoca macdougalii J.N. Rose), an endangered plant in the Cucumber Family (Cucurbitaceae), throughout its range in Arizona and Sonora, Mexico. The ultimate goals of the study are clarification of the status and distribution of T. macdougalii. The principal objectives of the study are: (1) delineation of the whole range of the species in Arizona and Sonora, and (2) determination of T. macdougalii population densities at selected Arizona sites.

To achieve project goals the contractor must be intimately familiar with the ecology and, perhaps even more importantly, the geography of an obscure and problematic plant and its habitat. In equal measure, the contractor must be capable of overcoming a host of logistical problems which should be expected in a biological study conducted in two countries simultaneously.

In the pages that follow we will convince the reviewers that there is no firm or association of individuals that even approach F.W. Reichenbacher & Associates in the expertise and capability essential to successful project execution. It is a matter of fact that no firm has surveyed more land, analyzed more relevant data, or committed more resources to the study of the Tumamoc globe-berry. Furthermore, no firm can claim to be capable of combining this depth of specific experience with expert knowledge of conservation laws, appropriate scientific tools, and the means of project coordination with relevant institutional and governmental entities.

A. Taxonomy and Description of Tumamoc Globe-berry

The Tumamoc globe-berry is a delicate vine in the dicot plant family Cucurbitaceae (Cucumber Family). It was discovered in 1908 at the northern base of Tumamoc Hill 1.8 miles west of downtown Tucson (Rose 1912). T. macdougalii is a facultatively dioecious vine with slender annual stems. Stems and leaves are glabrous. Leaves of adult plants are pedately parted into three lobes, highly variable in width of leaf and lobes. Leaves of juvenile plants are pentagonal in outline, the medial (distal)

division is much larger than the others. Male flowers are borne on racemes, and the perianth lobes are narrowly lanceolate, pale greenish-yellow. Female flowers are similar, but solitary on pedicels. Fruits are succulent, spherical to ovoid, pale green when immature with darker green vertical stripes. The stripes fade as the fruit becomes yellow, orange, and finally bright red at maturity (Rose 1912; Toolin 1982; Reichenbacher 1985, 1987a).

The geographically closest relative of T. macdougalii is Ibervillea sonorae (S. Watson) E.L. Greene, a native of Sonora, northern Sinaloa, and central and southern Baja California (Shreve and Wiggins 1964). While two or three varieties are usually recognized, only I. sonorae var. sonorae is sympatric with T. macdougalii. Reichenbacher and Felger (1985) examined sympatric I. sonorae and T. macdougalii in Sonora and found no evidence of hybridization. May's (unpubl. data) separations of flavonoid samples of T. macdougalii, I. sonorae var. sonorae, and I. tenuisecta (A. Gray) D.K. Small also supported the generic distinction.

B. Habitat and Distribution

Tumamoc globe-berry is always found beneath the sheltering canopies of shrubs and trees ('nurse plants'). The most obvious functions of the T. macdougalii nurse plants are (1) increased humidity, more plant-available soil moisture, and more fertile soil for seedlings and young juveniles, (2) concealment from predators, (3) support for the delicate vine, and (4) a means of displaying flowers to pollinators and mature fruits to potential dispersers.

In Arizona on well-drained coarse soils T. macdougalii is found in Sonoran Desertscrub, Arizona Upland subdivision, Paloverde-Mixed Cacti Associations dominated by foothills paloverde (Cercidium microphyllum), triangleleaf bursage (Ambrosia deltoidea), ironwood (Olneya tesota), buckhorn cholla (Opuntia acanthocarpa), chainfruit cholla (Opuntia fulgida), prickly-pear (Opuntia phaeacantha vars. major and discata), barrel cactus (Ferocactus wislizenii), saguaro (Carnegiea gigantea), creosote-bush (Larrea divaricata), range ratany (Krameria parviflora), whitethorn acacia (Acacia constricta), and ocotillo (Fouquieria splendens).

On poorly drained, fine-textured soils at lower elevations the species is found in Lower Colorado Valley Subdivision, Creosotebush-Bursage Associations, of the Sonoran Desert, in association with creosotebush, triangleleaf bursage, mesquite (Prosopis juliflora), and white bursage (Ambrosia dumosa).

In both Sonoran Desert subdivisions the species is found in desert riparian communities dominated by mesquite, whitethorn acacia, wolfberry (Lycium berlandieri and L. andersonii), and four-wing saltbush (Atriplex canescens). In some cases the wash habitats can be quite mesic and T. macdougalii has been found in association with a host of introduced and native weedy forbs and grasses characteristic of such situations.

In eastern Pima County Tumamoc globe-berry is found on soils derived from granite, rhyolite, andesite, andesitic basalt, basalt, limestone, and undifferentiated valley fill. The largest populations in this region are on soils formed from weathered amole granites in the Tucson Mountains. Soil texture varies from coarse to very fine.

On the Tohono O'Odham Nation west of the Tucson-Avra Valley area Tumamoc globe-berry is known from an old collection near Gunsight and it was recently discovered at the base of a limestone hill in the northern part of the Nation in Pinal County (Reichenbacher 1987b); so far this is the only record from a U.S. county other than Pima (Reichenbacher 1985).

Populations were found on the Tohono O'Odham Nation in areas dominated by allscale (Atriplex polycarpa) and mesquite, with several other common Sonoran Desert species, on poorly drained sodic-saline soils in the Santa Rosa Wash Valley and in the Great Plain (Reichenbacher 1985).

Tumamoc globe-berry was collected in the Dripping Springs Mountains on Organ Pipe Cactus National Monument in 1951 (Reichenbacher 1985), but recent surveys of the area were unsuccessful (W. Mikus pers. comm. 1988).

T. macdougalii was observed or collected at eight locations in the Mexican state of Sonora: two populations east of Guaymas, one south of Bahia Kino, three north and east of Bahia Kino, one near Carbo, and one west of Santa Ana. Reichenbacher and Felger (1985) failed to relocate plants at two out of three localities from the 1930's and 1940's. Two populations at locations not previously known to support the species were

located near Bahia Kino.

The Sonora localities, at which Reichenbacher & Felger (1985) discovered T. macdougallii, were supported in halophytic coastal scrub communities characteristic of the Gulf of California coast of central Sonora. The only other known Sonora localities, Santa Ana and Carbo, were dominated by interior, as opposed to coastal, Sonoran Desertscrub communities, with little or no evident soil salinity.

A major obstacle to an accurate estimate of the status and distribution of the Tumamoc globe-berry has been, and continues to be, the difficulty of predicting its occurrence (Reichenbacher 1985). The plant is widely scattered in a variety of habitats over an enormous and biologically poorly known range. This makes it impossible to estimate the abundance of the species throughout all, or even a portion of its range.

In eastern Pima County the plant occurs exclusively in isolated discrete populations, which are separated by considerable expanses of apparently suitable but unoccupied habitat. To date, 41 populations are known in eastern Pima County, averaging 47.34 plants each. Furthermore, individual plants are clumped within populations. Large adult plants are often surrounded with dozens of their own progeny. Clusters of 50-100 plants have been found beneath the canopy of a single nurse plant.

All Tumamoc globe-berry populations in the Tucson-Avra Valley area are between 600 and 900 m in elevation. Three populations are found on the lower slopes of small mountains in the Tucson Mountains, but none occur on bedrock-dominated mountain slopes. No populations have been found in the floodplains of any of the major drainage ways, such as the Rillito River, Brawley Wash, or the Santa Cruz River, although many populations are adjacent to or within the floodplains of minor washes.

The pattern of T. macdougallii distribution elsewhere throughout its range is largely unknown. Reichenbacher (1987b) and Reichenbacher and Felger (1985) documented apparently large and continuous T. macdougallii populations in mesquite-saltbush habitat of the Tohono O'odham Nation and in coastal halophytic scrub habitat in the Bahia Kino vicinity. The sampling intensities employed in these studies were not sufficient to provide conclusive data, but the results certainly indicate that the

proposed should concentrate on testing these habitats for ubiquity of occurrence.

C. History and Background of Study

Official recognition of T. macdougallii as a rare plant first came in 1980 when it appeared on the FWS "Notice of Review" (FWS 1980). T. macdougallii was placed in category 1 of the list of candidate plant species, indicating that FWS believed current evidence justified official listing as an endangered or threatened species. The status report prepared by Toolin (1982) recommended listing as a threatened species.

In September, 1983, F.W. Reichenbacher & Associates co-owner, Frank Reichenbacher, then employed by The Nature Conservancy, assumed responsibility for a special status plant survey of Phase B of the Central Arizona Project Tucson Aqueduct (CAP), under contract from BOR through FWS. T. macdougallii was included in the list of plants targeted for the surveys. On October 6, 1983, Mr. Reichenbacher discovered several T. macdougallii plants (7 adults, 14 seedlings¹) in the proposed aqueduct route. According to Mr. Reichenbacher's count (1984) this brought the number of known extant plants to 40 adults, 9 juveniles, and 126 seedlings (including only observations reported in 1983 and 1982).

These facts caused both FWS and BOR to recognize T. macdougallii as a potentially high priority endangered species. FWS began preparing a proposal to list T. macdougallii as an endangered plant and BOR began planning for conservation measures to avoid or reduce impacts to the plants.

BOR awarded a contract to the newly formed F.W. Reichenbacher & Associates in August, 1984, through FWS and Arizona State University. The scope of work called for a detailed survey of the status and distribution of T. macdougallii. The survey lasted for more than three months and was concentrated in the Tucson-Avra Valley area. F.W. Reichenbacher & Associates report on the study (Reichenbacher 1985) is the most in-depth and comprehensive analysis to date on the ecology, status, and distri-

¹ Plants observed with cotyledon leaves or leaf scars.

bution of T. macdougallii.

In his report on the 1984 T. macdougallii studies, Reichenbacher (1985) counted just under 2,000 individual plants known in existence, including 356 adults and 1,629 juveniles. This represented a remarkable increase in the number of individuals known, but was not unexpected. In 1983 and 1984 approximately 24,000 ha, nearly all in the Tucson-Avra Valley area and more than two-thirds under various F.W. Reichenbacher & Associates contracts, were searched for T. macdougallii. The results of the study did not reduce concern for the species. Indeed, evidence of increasing impacts from urban and suburban growth, vandalism of plants, and javelina predation actually highlighted the need for rapid federal action to conserve the species. The results of the 1984 surveys and studies and the numerous T. macdougallii surveys and studies conducted since then have not substantially altered perceptions of the species' status and distribution.

FWS officially proposed T. macdougallii for listing as a federally endangered species on May 20, 1985 (FWS 1985). The final rule was published by FWS on April 29, 1986 (FWS 1986) and T. macdougallii was added to the list of federally endangered species on May 29, 1986.

FWS and BOR had been discussing measures of reducing and avoiding impacts to the CAP T. macdougallii population throughout the listing process. On June 30, 1986, FWS released a Biological Opinion on the project. The Opinion drew attention to the inadequacy of recent surveys in allowing for accurate assessment of the species' status. Reasonable and prudent alternatives developed during the FWS and BOR consultations included the study proposed in this document. FWS suggested that if such studies documented the existence of considerably more T. macdougallii, the impact of the CAP on the species would be proportionately lessened.

D. Statement of Research Goals and Objectives

Goals

1. Clarify the distribution and range of T. macdougallii. Determine the northern, southern, eastern, and western limits of the species range and characterize, as accurately as possible, its

distribution within that range.

2. Clarify the status of T. macdougallii by assessing the threat of extinction of the species against previously reported and new distributional data and observations on potential threats.

Objectives

1. In the first project year -- August 1st to October 31, 1988 -- conduct a survey of the species throughout its range, maximizing the area searched and hence the number of populations potentially discovered. Also plan the surveys so that the northern, southern, eastern, and western limits of the species range are clearly delineated. Note current and potential threats to the species wherever found.
2. In the second project year -- August 1 to October 31, 1989 -- conduct intensive studies of population density, age structure, health, and known and potential threats of selected United States populations.

E. First Year Studies - Range Delineation

A complete and thorough survey of all 78,000 km² of the known potential range of T. macdougallii in a single field season is not feasible with the level of resources we believe BOR is willing to commit. We previously researched the level of survey detail and the sampling design necessary to generate data which would provide statistically supportable conclusions (Reichenbacher unpubl. data 1985).

Estimates of the number of quadrats and quadrat size needed to obtain statistically supportable estimates of the number of T. macdougallii populations throughout the range of the species were based on simulations of quadrat sampling in the Tucson-Avra Valley area -- the

* Date of initiation of field studies will depend on contract award date and timing of the onset of summer rains.

only area where enough distributional data is available -- and extrapolated throughout the range of the species. The results suggest that to be statistically testable a sampling design using 5.75 ha quadrats, requiring surveys of 134,000 ha of land², would be necessary. The labor demand does not include a substantial time investment for location and delineation of over 23,300 quadrats.

We believe a more pragmatic approach to the problem of accurate characterization of the range and distribution of T. macdougallii, based on a parsimonious definition of the study area will provide the necessary data and will be far more cost-effective. We will bound and stratify the study area on the basis of: (a) substrate and local environments, and (b) key climatological limiting factors

1. Stratification by Substrate and Local Environment

The first method of defining and stratifying the study area depends on current knowledge on the kinds of habitats in which T. macdougallii has not yet been found to occur. These were discussed in the previous section on habitat and distribution and include: (a) bedrock-dominated slopes of mountains, and (b) riparian scrub and deciduous riparian forest and woodland habitats of the active floodplains of large washes, streams, and rivers. The latter environments are probably unfavorable to T. macdougallii due to flood disturbance and the vine's inability to climb high enough to obtain sufficient sunlight.

The area determined to include the potential range of T. macdougallii will be stratified so that transect sites will avoid all mountains slopes and the active floodplains of major washes, streams and rivers. This will reduce the study area to a size that can more realistically be surveyed in a single field season.

2. Stratification by Key Climatological Characteristics

In order to identify the potential range of T. macdougallii we

² Assuming the surveyors space themselves out so that only 25% of the quadrat is actually effectively searched.

applied principle components analysis (PCA) to key climatological data from 46 weather stations in Arizona and Sonora. The results of the PCA accurately circumscribe the key climatic characteristics of known T. macdougallii habitat and identify additional potential habitat. Table 1 summarizes the key climatological characteristics required by T. macdougallii, Table 2 lists the stations and the pertinent data, Figure 1 shows the locations of the stations and our delineation of the range of T. macdougallii, based on the climatological data and regional topography. Figure 2 is an ordination of scores of individual stations on the first two factor axes resulting from the PCA.

The data was derived from Hastings (1964), Sellers and Hill (1974), and Sellers et al. (1985) and, although it was limited in detail, we believe it is adequate for such an analysis. The main climatic features of interest are (Turner and Brown 1982):

1. Total Summer Precipitation. T. macdougallii is entirely dependent on summer precipitation. The abundance of summer precipitation increases from the northwest to the southeast.
2. Total Annual Precipitation. The difference between total annual precipitation and total summer precipitation increases from the southeast to the northwest as the relative importance of the winter and spring rainy season increases.
3. Mean July temperature. These data characterize the severity of the summer environment. At similar elevations, sites with less summer precipitation are hotter in the summer.
4. Mean January temperature. Cool winter temperatures are directly related to latitude. T. macdougallii is extremely frost-sensitive and is therefore likely to be limited on the northern edge of its range by low winter temperatures.

Reichenbacher (1985) argued that overabundant summer precipitation⁴ in the south and southeast, low winter temperatures in the north, northeast, and west, lack of summer precipitation, with concomitant increasing summer temperatures, limits T. macdougallii in ways similar to

⁴ This condition results in tree and shrub density and cover too high for T. macdougallii to compete with.

Table 1. Maxima and minima of critical climatological variables for weather stations representing known T. macdougallii populations in Arizona and Sonora.

Parameter	Minimum	Maximum
Total Annual Precipitation (mm)	180	334
Total Summer Precipitation (mm)	100	222
Mean January Temperature (°C)	9	18
Mean July Temperature (°C)	28	32

that observed in many other desert plants (Turner and Brown 1982).

The PCA validates our earlier claims remarkably well. In Figure 2, hot dry sites are clustered in the lower left corner, cool wet sites predominate in the upper right, hot wet sites in the upper left, and cool dry sites in the lower right. The factor axes explain 90% of the variance, indicating that a two-dimensional ordination is ideal.

As is illustrated by the PCA, the interplay between these conditions is crucial in delimiting favorable habitat. Of particular interest is the apparent fact that low summer precipitation may be partially compensated for by mild summer temperatures and higher winter precipitation. Mean precipitation and temperature will not be useful statistics.

The climates represented at the following stations are well within parameters favorable for T. macdougallii, although the species is not currently known from their vicinities:

- s. Silverbell, Arizona
- G. Altar, Sonora
- I. Baviácora, Sonora
- J. Presa Cuahtemoc, Sonora
- M. Atil, Sonora

The identification of the Baviácora site is the one major surprise in the data. It lies on the Río Sonora, above Hermosillo, Ures, and El

Table 2. Climatological characteristics of selected locations in Arizona (lowercase letters) and Sonora (upper case letters). Precip. = mm; Temp. = °C; * = station is near a T. macdougallii population (Hastings 1964; Sellers and Hill 1974; Sellers et al. 1985).

Station	Fig. 1 Ref.	Summer Precip.	Annual Precip.	July Temp.	Jan. Temp.
San Luis	A	19	55	34	13
Yuma Int'l. Airport	a	20	66	34	13
Puerto Peñasco	B	24	73	29	11
Phoenix Int'l. Airport	b	63	178	33	11
Buckeye	c	69	189	33	10
Gila Bend	d	74	148	34	11
Mesa	e	74	206	32	10
Maricopa	f	84	190	32	9
Eloy	g	84	220	32	11
Casa Grande	h	90	212	33	10
Sacaton	i	93	222	32	10
Sonoita	C	100	185	32	11
* Organ Pipe Cactus Nat'l. Mon.	j	100	224	31	11
Ajo	k	109	224	33	11
* Santa Rosa	l	120	216	31	10
* El Carrizal	D	129	209	32	14
* Empalme	E	141	180	28	17
* University of Arizona	m	143	283	31	11
* Tucson Magnetic Observatory	n	143	302	30	9
* Cortaro	o	144	285	31	10
* Tucson Int'l. Airport	p	156	282	30	11
* Sabino Canyon	q	158	334	31	11
Sahuarita	r	162	269	29	9
Silverbell	s	163	323	30	11
* Anvil Ranch	t	165	287	30	9
* Guaymas	F	167	238	31	18
San Manuel	u	171	342	29	9
Hermosillo	H	173	240	33	17
Altar	G	173	258	32	13
Sells	v	173	311	30	10
Baviácora	I	187	278	30	14
Presa Cuahatemoc	J	199	301	30	13
* Carbo	K	212	282	31	15
* Santa Ana	L	222	319	29	12
Atil	M	229	338	31	12
El Oregano	N	256	344	35	17
Imuris	O	287	413	29	17
Tecori	P	306	395	32	16
Opodepe	Q	326	452	30	14
Ures	R	331	477	30	15
Moctezuma	S	343	471	30	12
Mazatan	T	367	488	31	16
Suaqui	U	388	525	32	15
La Dura	V	404	557	31	17
Tonichi	W	594	437	31	17
San Javier	X	649	459	25	12

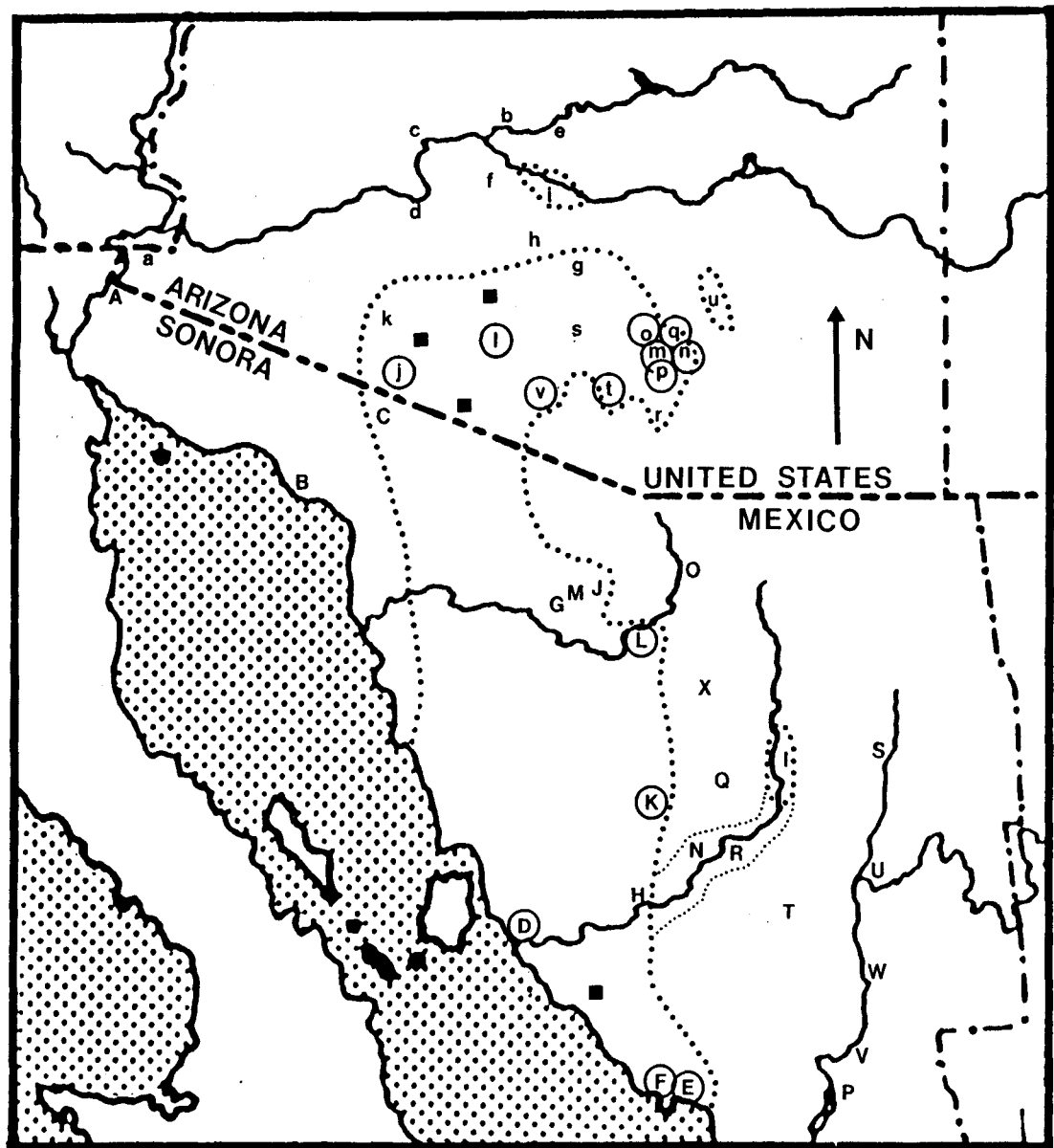


Figure 1. Range and distribution of Tumamoca macdougalii and distribution of 46 weather stations used in principle components analysis of key climatological characteristics. Potential range is enclosed in heavy dotted lines. A potential habitat corridor is tentatively mapped in fine dotted lines along the Rio Sonora from Hermosillo to Bavi  cora. Weather stations representing nearby T. macdougalii populations are circled, populations not represented by a weather stations are indicated with a ■. Weather stations are identified by lowercase letters (Arizona) and upper case letters (Arizona) and are listed in Table 1 and are used in the PCA ordination in Figure 2.

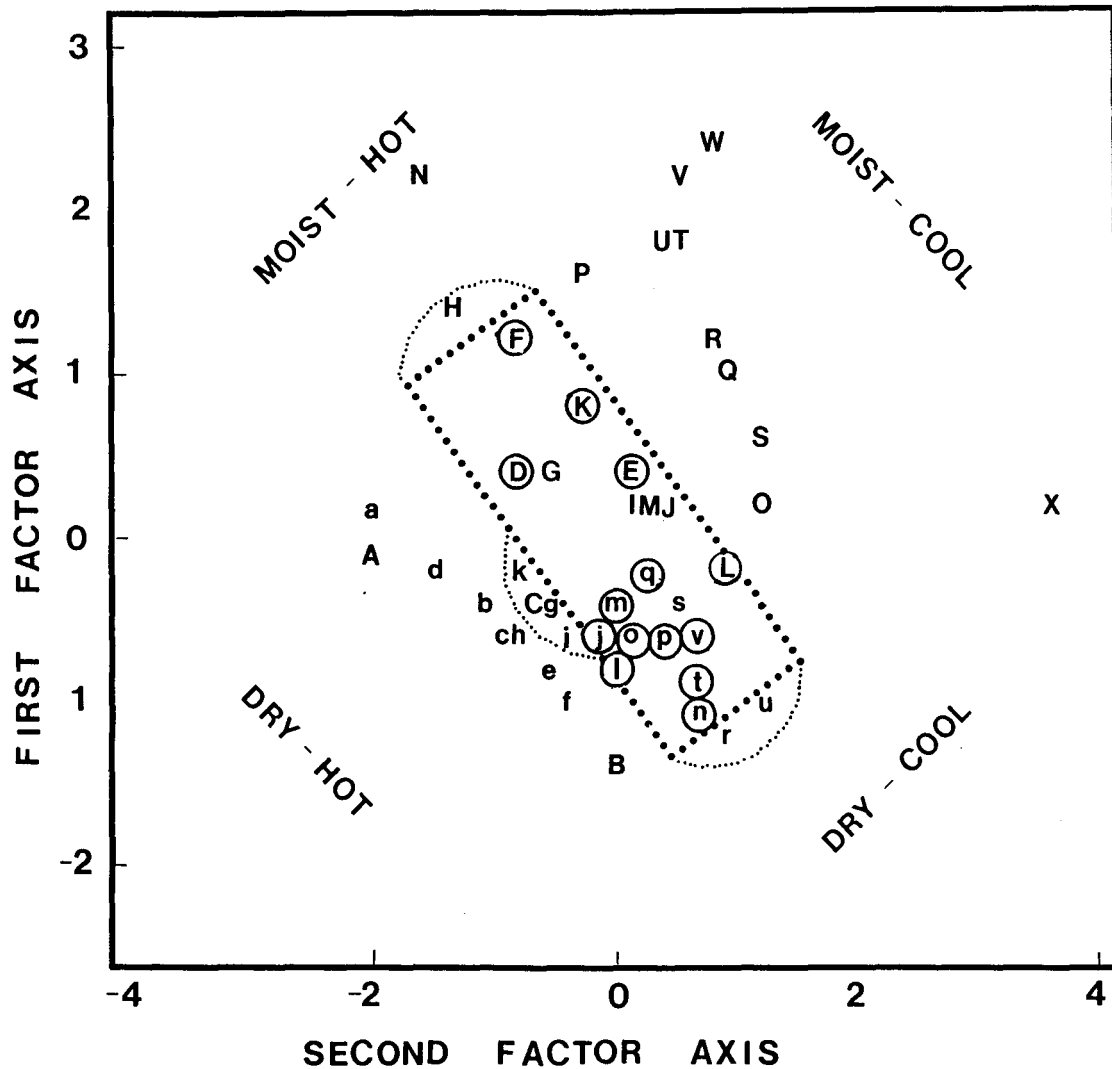


Figure 2. Principle components ordination of 46 weather stations in Arizona and Sonora. Stations are identified by lowercase letters (Arizona) and uppercase letters (Sonora) which are listed in Table 1 and mapped in Figure 2. The climatological "home" of *Tumamoca macdougallii* is outlined in a heavy dotted line. Stations representing nearby *T. macdougallii* populations are circled. Stations climatologically close to the *T. macdougallii* "home" and which are mapped in the potential range of the species are outlined in fine dotted line.

Oregano, none of which are, climatically speaking, particularly close to Baviácora. Hermosillo is much hotter, El Oregano is both hotter and wetter, and Ures is wetter. Baviácora is, nevertheless, included in the mapped potential range of T. macdougallii in Figure 1, with a tentatively drawn corridor of potential habitat along the Río Sonora connecting it with the main body of habitat.

The Altar, Atil, and Presa Cuahtemoc stations are within 20 miles of each other in north-central Sonora. In addition to falling well within the climatic limits of T. macdougallii they are definitely within its geographic limits as well.

The following stations appear to possess climatological characteristics which make them likely candidates for T. macdougallii:

- C. Sonoita, Sonora
- g. Eloy, Arizona
- H. Hermosillo, Sonora
- i. Sacaton, Arizona
- k. Ajo, Arizona
- r. Sahuarita, Arizona
- u. San Manuel, Arizona

These stations outline critical problems in defining the species' distribution. Eloy, Sacaton, Ajo, and Sonoita are adjacent to the northern limits of the range; these regions are deficient in summer precipitation and are cool in winter. Although Hermosillo receives 173 mm of summer precipitation, this may not compensate for high average summer temperatures. In contrast, though San Manuel and Sahuarita apparently receive sufficient summer rains, they may be too cool in the winter.

We conclude that all the other stations used in the PCA do not possess the critical climatological characteristics necessary to support T. macdougallii. The regions climatically represented by these stations are not included in the map of potential habitat of T. macdougallii.

The following narratives summarize the climatological geography of key distributional problems for the first-year investigations.

Western Boundary

The western limit of T. macdougalii lies on, or a few miles west of, the axis Ajo-Sonoita-Libertad. To delineate the boundary more precisely surveys will concentrate on the Ajo vicinity, north-central regions of Organ Pipe Cactus National Monument, the regions northwest of Caborca, and the region between Caborca and Desemboque.

Northern boundary

The northern boundary of the species includes an isolated island of potential habitat in the Gila River Valley surrounding the Gila River Indian Community town of Sacaton, the regions around and between the towns of Eloy and Silverbell, and the northern Tohono O'odham Indian Reservation, between Silverbell and Hickiwan. Surveys will concentrate on the regions surrounding and northwest of Silverbell, the plains surrounding the Vekol, Table Top, Sand Tank, and Sauceda Mountains, and the Gila River Valley between Sacaton and Maricopa.

The Gila River Valley between Sacaton and Maricopa, supports a distinctive saltbush (Atriplex polycarpa)-mesquite (Prosopis juliflora) vegetation association. This vegetation type is very similar to that found on the Tohono O'odham Indian Reservation in the Santa Rosa Wash Valley and in the Great Plain described above (p. 7) which supported large populations of T. macdougalii.

Eastern and Southern Boundary

Sahuarita, San Manuel, and a line along the axis Santa Ana-Carbo-Hermosillo-Empalme comprise the eastern boundary of the range of T. macdougalii, in addition to Baviácora. Surveys will focus on areas in the immediately vicinity of San Manuel, Sahuarita, and Baviácora. Surveys will also focus on the western side of the Valle del Río Zanjón, the Río Sonora valley immediately above Presa Hermosillo, and south along the western base of the Sierra Bacatete to the coast. The southern most point of the surveys will be in the vicinity of Potam, a small town on the Río Yaqui delta southeast of Guaymas, approximately 55 km southeast of Guaymas and 33 km south of the south and eastern most known locality for T. macdougalii (Las Guasimas).

In addition to clarifying the boundaries of the range of T. macdougalii, it will be necessary to survey many sites well within the mapped boundaries. Reference to Figure 1 reveals huge gaps in the known range of the species, especially in Sonora. The whole region from the Arizona border south to the Río Sonora, and from Caborca to Santa Ana and

Bahia Kino to Carbó is wild and botanically little known. Surveys will focus on the regions east of Sonoita below the Arizona border, the vicinity of Altar and the Rio Magdalena valley, regions north and north-east of Bahia Kino and the valleys between the Rio Sonora delta and Mexico Highway 15. The huge and unknown region between the Rio Zanjón and the coast will require wide-ranging surveys not focused on any particular region.

We do not believe it is necessary to survey in the Tucson-Avra Valley area where T. macdougalii surveys have covered over 30,000 ha of in the past five years. It is unlikely that surveys of the intensity we contemplate would add anything important to our knowledge of the area. In addition, we do not believe it is necessary to survey the Tohono O'odham Indian Reservation in the region of the Great Plain and Santa Rosa Wash Valley. These sites were surveyed by Reichenbacher (1986) in sufficient detail to establish the species' presence and delineate population boundaries. The main distributional issues to resolve in the United States involve potential habitat identified in the PCA at the eastern, northern, and western margins of the species' range.

3. Sampling Methods and Procedure

In our surveys of the Tohono O'odham Indian Reservation in the summer of 1986 we employed a line transect sampling method which was simple, efficient, and allowed the field crew to cover approximately the same acreage at each location. The method consists of a field crew of four biologists walking straight parallel lines, on a predetermined compass bearing, for a predetermined length of time (usually 1 hour; 30 minutes out and 30 minutes back). A crew member records compass bearings to nearby landmarks and references them to features on field maps, thus allowing the area searched to be very accurately located at a later time. The field crew members search for T. macdougalii as they walk, and call out to the crew leader when a T. macdougalii is observed. The crew member who finds a plant scans the spot rapidly, but thoroughly, and calls out a quick estimate of the number of plants present.

In one hour the transect averages approximately two linear kilo-

meters (1 km out and 1 km back) -- 8 km combining the transects of each field crew member in a four-person crew. In practice, the crew leader will vary the time walked as appropriate for the habitat and terrain in order to maintain consistency between transects. Assuming that each person effectively searches a belt 10 m wide, a one hour transect will cover approximately 8 ha.

Provided that travel time between study sites is minimized, the field crew will be capable of completing three to five study sites in one day. The field crew will be provided with a list of study site locations based on a four-transect per day, with the expectation that an average of about 3.5 transects per day will actually be completed. The excess sites will be considered alternatives in case of access difficulties or a shift in the local sampling strategy. Three field crews -- one in Arizona and two in Sonora -- working for 66 days, at a rate of 3.5 transects per day, each covering 8 ha, will complete a total of 693 transects (5,544 ha) -- 231 (1,848 ha) in Arizona and 462 (3,696 ha) in Sonora. The following is a preliminary description of transect locations.

ARIZONA

Sahuarita -- 20 Transects

Arizona State Trust Lands immediately east and southeast of the town of Sahuarita. Transects will not be located in the Santa Cruz River floodplain.

San Manuel -- 20 Transects

Arizona State Trust Land located east and south of the town of San Manuel. Most of the vicinity of the town is owned by ASARCO Mining Co. It will be important to choose sites as near as possible that possess the climatological characteristics identified in the PCA.

Sacaton -- 30 Transects

In and adjacent to the Gila River floodplain in the vicinity of the town of Sacaton; entirely on the Gila River Indian Reservation. It will be necessary to avoid large areas of abandoned agricultural lands in the Gila River floodplain.

Silverbell/Eloy -- 40 Transects

No significant natural vegetation remains in the Eloy vicinity and much of the vicinity of Silverbell is disturbed by mining activities or is dominated by the Silverbell Mountains. The sampling strategy will avoid these areas and still provide a meaningful sample. Transects will be located on U.S. Bureau of Land Management and State Trust lands east and west of the town of Silverbell, in the vicinity of Cerro Prieto, near the western bases of Picacho Peak and the Picacho Mountains, and near the base of the Sawtooth Mountains.

Northern Tohono O'odham Indian Reservation -- 60 Transects

Plains east of the Slate Mountains, Tat Momoli, and the Silver Reef Mountains; western Santa Rosa Wash Valley, between Gu Achi and the Vaiva Hills; valleys between the Vekol and Castle Mountains on the east and the Sand Tank Mountains and Cimmaron Peak on the west; upper Hickiwan Valley; and the Pozo Redondo Valley; vicinity of Gunsight. (Every effort will be made to obtain access permission prior to the end of the field season, but it is probable that it will be necessary to postpone work on the Reservation until 1989. It is even possible, that, despite our best efforts, access permission will be denied. In this event, transects planned for the Reservation will be applied to other key regions.)

Ajo/Table Top Mountains -- 60 Transects

Vekol Valley west of Table Top; valleys between the Sand Tank and Sauceda Mountains and between the Sauceda and Batamote Mountains.

Ajo/Lukeville -- 30 Transects

Valley of the Ajo; plains north of Dripping Springs; and the Sonoita Valley.

SONORA

Sonoita/Caborca/Presas Cuahtemoc -- 80 Transects

Plains of the Rio Sonora between Cerro Cubabi and Cerro de San Longino; Plains of the headwaters of Arroyo del Coyote between Sierra del Humo and the town of El Coyote; plains at the headwaters of the Rio Seco in the vicinity of San Rafael; plains between the Rio Altar and the Rio Magdalena.

Caborca/Bahia Kino -- 125 Transects

Valleys between the Sierra la Vibora and the Sierra el Viejo; valleys east of the mountains lining the coast from Bahia Kino north to Puerto Libertad (a huge almost featureless region); plains in the vicinity of Playa San Bartolo northeast of Bahia Kino.

Santa Ana/Hermosillo -- 125 Transects

Vicinity of Santa Ana east to the base of the Cerro de la Mentana and west to the Sierra la Vibora and north along the western base of the Sierra Cibuta and the Sierra Magdalena. Special concentration on the Valley of the Río Zanjón which runs from north to south from Benjamin Hill to the Río Sonora just above Hermosillo.

Bahia Kino/Hermosillo to San Carlos/Potam -- 150 Transects

Río Sonora delta (avoiding large agricultural areas); Río Sonora to Sierra Libre; valleys south of Sierra Libre between Sierra de la Perinola and Sierra de la Pasion; valley between Sierra Libre and Cordillera del Carrizal; Valle de Guaymas; especially the eastern margins at the base of the Sierra del Bacatete; coastal plain south and west of the Sierra del Bacatete.

Baviácora -- 40 Transects

Río Sonora valley in the immediate vicinity of Baviácora.

All sampling localities will be preselected and plotted on field maps to be carried by the field survey crews. The sites will be generally located in the regions described in the previous section. In order to minimize the amount of travel time spent by the field crew, most, if not all, survey sites will be located on major paved and dirt access roads.

The sampling method described above combines accuracy and efficiency with simplicity and repeatability. It allows the field crew supervisor to ensure that the crew's time is used in the most efficient manner possible. This method, combined with advanced site selection will guarantee that the most area can be searched in the most critical regions in the

least amount of time.

The observational data gathered on the transects will be important in examining the autecology of T. macdougallii. One of the most remarkable and perplexing aspects of the ecology of T. macdougallii is its ability to persist in a variety of very different habitats. Observational data on soils and species lists, coupled with primarily geographic and physical site data such as elevation, latitude and longitude, slope, exposure, and others will assist our understanding of this phenomenon.

The data to be recorded are listed below. All Arizona transects in which T. macdougallii are found will be marked with surveyors flagging tape to facilitate relocation for second-year investigations.

FIELD DATA -- FIRST-YEAR INVESTIGATIONS

1. Field Crew Supervisor Name
2. Date
3. Location Description - Brief narrative describing access road, nearest town, and nearby mountain range.
4. Transect Bearing - To the nearest degree; compass bearing indicating the orientation of the transect.
5. Transect Duration
6. Landmark Compass Bearings - To the nearest degree; referenced to landmarks identified on a topographic map. The site will be mapped as accurately as possible in the field, but will be checked later against the compass bearings.
7. Photograph Frame Number - A color transparency will be obtained of transect sites showing representative land-
scapes, T. macdougallii populations, and any other features which should be photographically recorded.
8. Vegetation Description - Brief narrative description of vegetation association, cover, structure, and distribution; notations of any unusual local ecological characteristics, such as soil types and grade slopes, presence or absence of large areas of riparian vegetation included in the transect.
9. Perennial Plant Species List - As the crew walks a list of perennial plant species is made and each species is coded as to local importance (i.e., rare, uncommon, common, co-dominant, dominant).
10. Tumamoca macdougallii - A running tally of all plants seen on the transect will be recorded.

F. Second Year Studies - Population Density Studies

Second-year investigations will focus on determining population size, population age structure (i.e., proportions of adults, juveniles, and seedlings), and health of selected populations in Arizona. The success of the second-year studies will depend on (a) the selection of study sites and, (b) the sampling method.

1. Study Site Selection

Selection of study sites for this phase of the project will depend on the results of the first-year investigations. We recommend that none of the sites included in the comprehensive 1984 surveys of F.W. Reichenbacher & Associates (Reichenbacher 1985) be used (although, in the unlikely event that few or no new populations are discovered in 1988, it may be necessary to include these). Sufficient data already exists on 40-50 populations in the 1984 study area.

We do recommend visits to the Great Plain and Santa Rosa Wash populations discovered by F.W. Reichenbacher & Associates on the Tohono O'odham Indian Reservation (Reichenbacher 1987b). We predict that these will be found to be the largest Arizona populations of the species. Unless the first-year investigations reveal an important and unanticipated research question the Great Plain and Santa Rosa populations should be given priority in second-year studies.

The Tohono O'odham populations were surveyed using the transect method described above (p. 20). For reasons which will be described below (p. 26), this survey technique is not suited to the second-year tasks. Means of obtaining more accurate density estimates from a more rigorous technique are described below.

Our recommendations for sites to be selected must remain simple and flexible. It is desirable to obtain data from a wide variety of habitats throughout the documented range of the species in Arizona. This is important to avoid focusing on habitats or regions in which some site factor or accident of dispersal or biogeography resulted in a locally atypical distribution pattern. It is also an important reason for avoiding sites in the Tucson-Avra Valley area. Here the distribution of the

species in discrete isolated populations on the extreme northeastern fringe of the range may be quite anomalous.

2. Sampling Method and Procedure

The transect sampling procedure employed by Reichenbacher (1987b) in surveys of the Great Plain and Santa Rosa Wash populations, and which is proposed here for the first-year investigations, will not provide the data necessary to estimate population density or to determine population age structures. Field crews will be walking the transects as rapidly as possible (although they will be careful to thoroughly scan the habitat) and will not be able to count every plant they encounter, much less be able to determine age-class of every individual. In the Tucson-Avra Valley area we found up to 100 individual T. macdougalii plants in areas of less than 5 square meters (Reichenbacher 1985). In addition, despite measures which will reduce variability to some extent, the transects will not cover the same area in every case. The unit area employed in the second-year studies must be more rigorously defined to allow a reasonably accurate density estimate.

We suggest that the second-year studies rely on quadrats of approximately 8 ha the same size as the first-year transects. Each will be placed at the site of a transect from the first-year studies and positioned in such a manner as to include all of the previous transect. This will require a quadrat approximately 100 meters long and 80 meters wide. Quadrat boundaries will be measured with a pedometer, on lines determined by compass, and will be marked with surveyor's flagging tape.

The four-person field crew will walk the site in the same manner as described above for the first-year transects, but the entire quadrat will be systematically searched. Every time a T. macdougalii plant is encountered the crew will stop and search its immediate vicinity for more. All plants will be first marked with wire surveyor's flags to allow each plant to be properly counted. Each plant will be examined to determine age-class. It is necessary to work one group or clump of plants at a time, initially marking all plants with wire surveyor's flags, and then making a count. The larger plants must be closely examined for the

presence of flower buds, flowers, and fruits to distinguish adult from juvenile plants. The field crew members must get down on their hands and knees to check the smallest plants for cotyledon leaves and leaf scars.

The process of making an accurate count of the actual number of plants present, even in an area of only two to three square meters, is extremely time-consuming. The vines are frequently clumped and tangled with one another and are very difficult to distinguish from the background vegetation. It is often necessary to patiently track a stem from inside the sheltering tree or shrub canopy for several meters to the point of emergence from the ground. Seedling juvenile plants may be very densely clustered among thorny shrubs and cacti.

We estimate that a four-person field crew will be able to complete an average of 2 density quadrats per day. The actual number completed will vary enormously. Many quadrats will include only no or only a few T. macdougallii plants while some could include several hundred. The labor involved in obtaining the required data will vary accordingly. Second-year investigations of 405 ha (1,000 acres), covered in 50, 8 ha quadrats, will require approximately 25 field days to complete.

FIELD DATA -- SECOND-YEAR INVESTIGATIONS

- | | |
|--|--|
| 1. <u>Field Crew Supervisor Name</u> | 5. <u>For Each T. macdougallii:</u> |
| 2. <u>Date</u> | a. Age-Class - A= adult, PA= Probable Adult ⁵ , J=juvenile, S=seedling |
| 3. <u>1988 Transect Number</u> - Reference to code number given to 1988 transect. | b. Nurse Plant(s) - The one to three shrubs or trees providing shade and shelter to the plant. |
| 4. <u>Comments</u> - Peculiarities of quadrat or quadrat site; especially description of differences in quadrat siting or orientation from 1988. | 6. Notes - Observations on site quality and any threats or impacts to the population. |

⁵ Flowers or fruits not observed, but large plant size (especially large stems) suggests the plant achieved adult status, though it is not currently expending reproductive effort.

G. Determining Voucher Specimen Needs

Voucher specimens of T. macdougalii will be essential to the scientific validation of the study. It has been our experience that even trained botanists occasionally confuse T. macdougalii with its sympatric relative Ibervillea sonorae. Although we have every confidence in the ability of our field crew members to distinguish the two, others may feel more comfortable if voucher specimens are available for confirmation.

The field crew will adhere to "Native Plant Collecting Conservation Guidelines", a brochure adopted by The Plant Conservation Roundtable on June 13, 1986. It provides a basis for determining when collections are appropriate and how many specimens should be collected.

A single specimen, with flowers or fruits, will be collected and pressed to dry from every new population. The amount of material will be limited to that necessary to fill a standard-sized herbarium sheet. No tubers will be collected -- this should not be necessary at all.

In practice it will be very difficult, if not impossible, for one to determine whether or not two specimens from separate localities represent new populations or the same population. The sampling design is not suited to determining the extent of populations. The field crew will be instructed to limit T. macdougalii collections to new valleys, or basins, or to new portions of very large valleys. We anticipate that collections closer than 50 km apart would be necessary only rarely, if at all.

H. Data Analysis

The raw data will be condensed and reduced to a series of descriptive statistics. These statistics will illustrate general trends and patterns in distribution and abundance. If between-plot variation is low and the transects are more or less randomly distributed throughout the study area, or in portions of the study area, sampling means may be statistically tested.

Mean and standard deviation of the number of T. macdougalii per transect and the less easily quantified geographical data will be the most important data derived from the first-year investigations. The geographic data may be easily plotted on a small scale map, (from

1:1,500,000 to 1:3,000,000) in the form of isolines representing the probability of occurrence of T. macdougalii abundance throughout its range. This will provide a quick reference to identify regions of high potential abundance for further study and to alert land and project planners.

Collateral ecological data collected during the first-year investigations may be used to develop qualitative models for predicting T. macdougalii occurrence. Associated species lists will be incorporated in a vegetation classification using the framework developed by Brown, Lowe, and Pase (1979) with modifications by Warren et al. (1981). T. macdougalii occurrence data will be correlated with vegetation types and associated species.

The most significant results of the second-year investigations will be a more accurate estimate of the number of plants in the two large Tohono O'odham populations and the quantification of age-class structures in a variety of habitats. This latter is especially important; the only age-class structure data available has been obtained in the Tucson-Avra Valley area. Although there may be too much variance in the data for statistical testing, we expect to calculate descriptive statistics. Mean and standard deviation of the number of plants per quadrat and mean and standard deviation of the number of plants per quadrat in each age-class will be the most important resulting statistics.

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II. PLAN OF WORK

The research design described in preceding sections is the product of a considerable amount of scientific research, but F.W. Reichenbacher & Associates has not forgotten to consider the mundane aspects of the project as well. We are cognizant of, and feel we are exceptionally capable of, contending with difficulties in project execution which would overwhelm most other firms. The special requirements of foreigners doing business in Mexico and the well-known difficulties encountered by Americans attempting to obtain native plant collecting permits in Mexico are especially troublesome. In the United States the project will be conducted on lands of several different state and federal agencies, each with its own rules and regulations governing research, access, and native plant collection. Obtaining the cooperation of the Tohono O'odham Nation in conducting surveys on the Reservation will require a lengthy process of negotiation with numerous tribal agencies.

Despite this we are prepared to proceed with the study according to the schedule outlined in the RFP with only one minor alteration in the project schedule to accommodate the Tohono O'odham.

In the first year, successful project execution will mainly depend on: (1) rigorous delineation of the study area and judicious site selection, and (2) a field team capable of carrying out the research plan. In the second year the most critical factors are: (1) selection of the most representative sites for intensive study, and (2) the capability of extracting the most information possible using the proposed method. Our execution strategy will implement what is fundamentally a simple and straightforward research design in the most efficient manner possible.

A. First-Year Studies

The purpose of the first-year studies is the delineation of the range and distribution of T. macdougallii through surveys conducted throughout its range. We propose to design the surveys around a study area stratified on the basis of critical habitat parameters and delimited on the basis of a predictive climatological model. The surveys will be conducted by three four-person field crews, one assigned to Arizona and

the other two assigned to Sonora. We are happy to announce that F.W. Reichenbacher & Associates and the University of Sonora School of Agriculture have worked out a tentative agreement to implement the study. It is likely to be the first of its kind between a United States firm and a Mexican institution which deals with an endangered plant species. We feel this is an especially important step since the Endangered Species Act of 1973, which provides the legal impetus for this study, clearly encourages United States government agencies to support the efforts of foreign countries in recognizing and managing their endangered species.

This is an ideal opportunity for the U.S. Bureau of Reclamation to take positive forward-looking steps to help the government and people of Mexico recognize these needs. All too often American scientists are sent to foreign countries to collect data; they return to the United State and rarely share their findings with scientists and concerned officials the host country. These sorts of opportunities can provide the catalyst that nations like Mexico are so in need of.

The proposed study will be executed in the following steps.

1. University of Sonora Cooperative Agreement

We are very pleased to announce that the University of Sonora School of Agriculture, located in Hermosillo, Sonora, and F.W. Reichenbacher & Associates have arrived at a tentative agreement to execute the proposed study of Tumamoc globe-berry. The School has expressed its interest and desire in working with F.W. Reichenbacher & Associates on this project. F.W. Reichenbacher & Associates will assign its own Field Crew Supervisor, Rogelio A. Juarez-Gonzalez, a native of Sonora and a citizen of Mexico, to lead the Sonora studies. In addition, the Mexican botanist, Diego Valdez, will be the botanical expert for the Sonora studies. He and the project's Principle Investigator, Frank Reichenbacher, will provide all of the necessary technical supervision of a field crew composed of professors and students of the School of Agriculture. The School will provide the labor for the project, assigning crew members and arranging for vehicles. In addition, Diego Valdez, currently curator of the School's herbarium will assume responsibility for collecting, labelling,

and curating all plant specimens. The specimens will be housed at the School's herbarium. Under the appropriate United States and Mexican permits the specimens will be shipped to the Bureau of Reclamation, with the rest of the project deliverables, for examination and verification.

F.W. Reichenbacher & Associates will continue to work on finalizing the agreement with the School during the proposal review process. We are acutely aware that delays in initiating field work might seriously compromise the research design. It is our intention to obtain a signed agreement prior within two weeks after contract award. We tentatively plan to begin field work on August 1, 1988. Essentially the School has already agreed to provide labor, herbarium facilities, and will at least arrange to procure four-wheel drive vehicles.

2. Assemble and Instruct Sonora and Arizona Field Crews

Rogelio Juarez, the Sonora Field Crew Supervisor, and Robert H. Perrill, the Arizona Field Crew Supervisor, are responsible for assembling the field crews and assigning field duties⁶. The Principle Investigator will work closely with both crews, accompanying field crews and travelling back and forth between them to make sure that the research design and plan of work will be adhered to.

The Sonoran field crews will be mainly composed of undergraduate students majoring in biology and related fields in addition to the project's Sonora botanist, Diego Valdez. The Arizona field crews will be composed of biologists and graduate students majoring in biology. They will instruct the field crew members and make certain that each member understands and is capable of fulfilling his or her responsibilities.

Special employment conditions are likely to be attached to access permission on the Gila River Indian Reservation and the Tohono O'odham Indian Reservation. Both tribal governments require that all non-Indian contractors operating on the Reservation consult with their respective Tribal Employment Rights Offices (TERO) to determine whether or not and

⁶ Sr. Juarez' duties require a great deal of responsibility not called for in his Arizona counterpart; his wages are calculated at an accordingly higher rate.

to what extent the contractor will be required to hire tribal members. F.W. Reichenbacher & Associates has hired tribal members many times in the past and has developed a good working relationship with TEROs of both tribes. We anticipate hiring four Indian guides from each Tribe for the duration of the studies on their reservations.

All field study assignments will be made on the basis of a four day work week. Field crew members will probably not be capable of remaining longer than four days continuously in the field under the extremely harsh conditions they will encounter.

3. Determine Study Area and Locate Transect Sites

The study area will be identified as discussed in first section of this proposal, according to topography, local environment, and key environmental characteristics.

The transect selection process will include the following steps.

a. Stratify Study Area by Substrate and Local Environment

The study area will be stratified so that all areas on rocky mountain slopes and active floodplains of all major rivers, streams, and washes are excluded. To judge from all currently known sites, T. macdougallii should not be expected to occur in these habitats.

b. Stratify Study Area by Key Climatological Characteristics

The boundaries of the study area will be delimited according to the climatological analysis described in the section on research design. Sites identified as potential habitat, but from which T. macdougallii is not yet known, will receive the highest priority.

c. Determine Transect Locations

All transect sites will be chosen and mapped in advance. The Field Crew Supervisors and the Principle Investigator will use the guidelines discussed in previous sections to select transect site locations. Approximately 780 transect sites will be selected and mapped at 1:250,000 scale for both Arizona and Sonora, 1:50,000 scale for Sonora, and 1:24,000 or

1:62,500 scale maps (whichever largest scale is available). These maps will be carried into the field by the Field Crew Supervisors.

In addition to the stratification process outlined above it will be necessary to restrict all Arizona transect sites to public lands. In the short time involved it will not be feasible to obtain rights-of-entry from what may turn out to be dozens of private landowners. There is more than sufficient public lands in all of the key regions of the study area to accommodate the research design without compromise.

The site transect assignments are based on 52 field days for each field crew at 5 transects per day. A total of 780 transects will be assigned; 260 for Arizona and 520 for Sonora. It is expected that transects will actually be completed at a rate of about 3.5 per day.

In order to minimize travel time transects will be located along major roads.

4. Obtain Access Permission and Collecting Permits

The Principle Investigator will undertake all responsibility for obtaining access permission and collecting permits. He and the Research Assistant/Interpreter, Ms. Salo, will address Mexican permitting requirements in a trip to Hermosillo soon after the contract is awarded. The following is a summary of permit and coordination needs by landowning agency and government.

a. Federal Endangered Species Collecting Permit

A federal permit is required to collect T. macdougallii on federal lands (BLM, National Monument, and Tribal lands). Our application will be made to the Regional Director of the U.S. Fish and Wildlife Service in Albuquerque, New Mexico. We have already notified the Regional Botanist in Albuquerque and were assured that the permit could be issued in a timely fashion with a proper application.

It will be necessary to obtain a federal import permit from the U.S. Fish and Wildlife Service's Office of Management Authority in order to ship the Mexican voucher specimens to BOR for inspection of final deliverables. This will be obtained after the 1988 field season is completed

when the total number of specimens involved will be known.

b. U.S. Bureau of Land Management Lands

The BLM has no official permitting system for plant collection on BLM lands, although they require compliance with Endangered Species Act and State of Arizona requirements. The BLM Phoenix District Office botanist has been notified of the project and the need for voucher specimen collection. He requested a letter explaining the project and indicated that as long as all other applicable requirements are met the BLM would cooperate.

c. National Park Service Lands

The Resource Management Specialist at Organ Pipe Cactus National Monument has been notified of the project and the need for voucher specimen collection. We were advised that if all other federal and state requirements are met an application can be processed promptly. We were also advised that a condition of the permit may be that voucher specimens will have to be housed at the Monument herbarium.

d. Gila River Indian Reservation

The Gila River Indian Community Physical Resources Department administers the Community's Native Plant Protection Ordinance. The ordinance is modelled after the Arizona Native Plant Law and specifically lists T. macdougallii as a protected plant. The Department's Director will be notified of the project and the need for voucher specimen collection. His recommendations on a permit application will be followed.

Application will have to be made before the Natural Resources Committee of the Tribe and possibly before the Tribal Council as well. It may also be necessary to meet with representatives of the Districts where transects are planned.

The Community is currently planning for substantial growth in agriculture on the Reservation with its anticipated acquisition of Colorado River water through the Central Arizona Project. We will approach the Community with the idea that our surveys conducted now, at

no cost to them, when combined with surveys farther south, may considerably assist their environmental planning efforts. If the proposed surveys in the Sacaton and Eloy areas result in no T. macdougallii occurrences, it will be difficult to justify requiring the Community to survey their project areas for the species.

e. Tohono O'odham Nation

The Tohono O'odham have no native plant protection ordinance, but access permits will be required for field crews. It will be necessary to present applications before the Natural Resources Committee, the Tribal Council, and the District Councils of the districts involved (Sif Oidak, Gu Achi, and Hickivan). A very lengthy process of negotiation will be required, and although every effort will be made, it is likely that access permission will not be obtained in 1988. In fact, it is not at all inconceivable that access permission will never be granted.

f. Arizona State Trust Lands

Collection of plants protected under the Arizona Native Plant law is regulated through the Arizona Agriculture and Horticulture Commission. We have already notified the Commission of the project and the need for collecting permits. The project Principle Investigator has a current scientific/educational permit from the Commission. It will be necessary to request an amendment to the permit to enable collection of T. macdougallii, which is protected under the Arizona Native Plant Law. We will also obtain a permit authorizing collection of T. macdougallii for the Arizona Field Crew Supervisor. No other laws or regulations will restrict our activities on State Trust lands.

g. Mexico Permits

The University of Sonora will ensure that Sr. Diego Valdez and his assistant will be authorized to collect the voucher specimens necessary for the project. During 1988 and 1989 the Principle Investigator and the Research Assistant/Interpreter will work with the University to clarify and comply with all Mexican permit requirements necessary to ship the

voucher specimens to BOR for inspection of deliverable items.

5. Assign Weekly Survey Tasks

The field crew supervisors and Principle Investigator will establish schedules for transect surveys by compiling a list of transects to complete each 4-day week. Each field crew should be able to complete 12 to 20 transects each work week (average of 14). The list of transects will be planned so as to minimize travelling time between each site. The field crew supervisors will make sure they have all the maps required for each week's assignments. Many sites will turn out to be located in unsuitable habitat, such as cultivated fields. Alternative sites will be included in the assigned transect lists so the field crew will not have to stop work to wait for additional site assignments.

6. Conduct Field Studies

The Arizona and Sonora field crews will operate independently. Completion of a typical transect will involve the following steps.

a. Select Transect Coordinates and Orientation

If possible the transect will begin at a point 100 m from the access road and will be oriented perpendicular to it. The responsible field crew member will use a pocket transit accurate to 0.5 degrees to determine the direction of the transect and to take compass bearings from the transect origin to nearby landmarks appearing on the appropriate topographic map.

c. Walk Transect

The field crew members will line up abreast in a line parallel to the road and about 10 m apart from each other. They will then walk in the direction determined previously. One field crew member will time the duration of the transect and tally all T. macdougallii found, while another will characterize the vegetation, list all perennial plant species, and observe and note other relevant environmental conditions and features. The field crew will walk in parallel straight lines as much as possible. The crew will walk for a predetermined length of time (about 30 minutes) and then return, walking a second set of four transects paral-

lel, and adjacent to, the first one. While the crew is walking the field crew member on the far left will tie lengths of surveyor's flagging tape to trees and shrubs every 10 to 50 m to mark the left boundary of the first set of transects. On the return, the person in the far left position will remove the flagging tape.

When T. macdougallii is found on Arizona transects the location will be marked with surveyor's flagging tape to facilitate relocation for second-year studies. When it is determined that a voucher specimen is required for the site, a single specimen, consisting of an approximately 50 cm long segment of stem with flowers or fruits will be collected and preserved in a standard herbarium press.

If necessary, representative photographs will be taken of key site features and of any plants found. The field crew supervisors will be responsible for obtaining representative photographs of T. macdougallii plants and their habitats.

7. Field Crew Management - Sonora Studies

Rogelio Juarez, a native of Sonora and a citizen of Mexico will lead the Sonoran field crews. He will act as liaison between the Principle Investigator, Frank Reichenbacher, and the University of Sonora. Personnel at the University which will be most closely involved include Marcos Teran, Academic Director, and Don Johnson, Professor of Range Science. Sr. Juarez and the School will assemble field crews of qualified biologists, arrange four-wheel drive vehicles, instruct the field crew members, conduct the surveys, record data, and make sketch maps detailing the location of each T. macdougallii found in relation to the surrounding landscape. Sr. Juarez will assign field duties, including collection of voucher specimens, using compasses and pedometers, setting up transects, flagging transects, mapping localities, recording associated plant species, and characterizing vegetation and site characteristics.

The Principle Investigator and Research Assistant Lucinda Salo, who will act as interpreter, will accompany the Mexican field crews for at least the first week of the field studies. This will ensure that both the Arizona and Sonora field crews are following the same procedures in

survey methodology and data collection.

Sr. Juarez will work with F.W. Reichenbacher & Associates Business Manager, Lari-Ann Clifford-Reichenbacher, on all business matters relating to employees compensation, acquisition of field supplies, and access problems.

The two Sonora field crews will travel together and each crew will be assigned every other transect site on the planned travel routes.

Due to the need for effective liaison and a considerable amount of independent activity the Sonora Field Crew Supervisor will be compensated at a higher wage rate than his Arizona counterpart.

8. Field Crew Management - Arizona Studies

Robert H. Perrill, Field Crew Supervisor for the Arizona studies, will lead the Arizona field crew. The Principle Investigator will work very closely with Mr. Perrill, accompanying the Arizona field crew on field surveys as necessary, to ensure that the research design and plan of work will be followed.

Mr. Perrill will assemble field crews of qualified biologists, arrange transportation, instruct the field crew members, conduct the surveys, record data, and make sketch maps detailing the location of each T. macdougallii found in relation to the surrounding landscape. He will assign field duties, including collection of voucher specimens, using compasses and pedometers, setting up transects, flagging transects, mapping localities, recording associated plant species, and characterizing vegetation and site characteristics.

Mr. Perrill will work with F.W. Reichenbacher & Associates Business Manager, Lari-Ann Clifford-Reichenbacher, on all business matters relating to employees compensation, acquisition of field supplies, and access problems.

9. Voucher Specimen Collection and Curation - Sonora Studies

Señor Diego Valdez, who is currently curator of the herbarium of the University of Sonora School of Agriculture, will accompany the Sonora field crews and supervise and lead all plant collection efforts. He will

collect voucher specimens for one field crew and select and assign collection responsibilities to a qualified individual for the second field crew. He will manage and curate all Mexican voucher specimens, making sure they are properly preserved, mounted, labelled, and stored.

10. Voucher Specimen Collection and Curation - Arizona Studies

Robert Perrill, Arizona Field Crew Supervisor, will collect all voucher specimens and ensure that all are properly preserved, labelled, and stored. All specimens will be stored at the University of Arizona Herbarium, except for any collected on Organ Pipe Cactus National Monument, which will be sent to the Monument's own herbarium.

11. Data Analysis - First-Year Studies

The field crew supervisors will collate all data resulting from the first-year studies. This includes data sheets, miscellaneous notes, journal entries, photographs, and maps. They will make sure that all the data assembled is legible and accurate.

Mr. Reichenbacher will analyze all data as described in the previous sections and will draft and prepare all maps required of the project.

Data reduction and analysis will include the following:

- Lists of all transect sites with elevation, latitude and longitude, compass bearings to prominent landmarks, and township, range and section (in the U.S. only).
- Mean and standard deviation of the number of T. macdougalii plants per transect.
- Tables listing vegetation and soil types encountered scored to indicate presence or absence of T. macdougalii.
- Tables listing perennial plant species encountered scored to indicate presence or absence of T. macdougalii.
- A map at 1:1,500,000 to 1:3,000,000 scale showing isolines of T. macdougalii abundance throughout its range.
- A map at scale 1:1,000,000 showing all currently known T. macdougalii localities; those known prior to and as a result of the proposed study.

- Revised principle components analysis using key climatological data to test the predictions of T. macdougallii distribution made in this proposal.

B. Second-Year Studies

The purposes of the second-year studies is to obtain estimates of the population density, age structure, and health of T. macdougallii in selected localities in Arizona. Study sites will be chosen after BOR and FWS have had the opportunity to review results of the first-year studies and recommendations for second-year studies made by us in the interim report covering the first-year studies. We have already made general recommendations in the research design section of this proposal.

As proposed in the section on research design, the second-year studies will rely on intensive study of 50, 8 ha, quadrats. Each quadrat will be thoroughly searched for T. macdougallii, all plants will be counted, their age-classes will be determined, and observations on health of the population and potential threats will be recorded.

The following steps will be required for execution of the proposed second-year studies.

1. Determine Study Sites

The interim report on first-year studies will contain recommendations and proposals for second-year studies. We assume that BOR and FWS will, in consultation with F.W. Reichenbacher & Associates, select study sites in Arizona which will be representative of the distributional and ecological range of T. macdougallii as far in advance of the 1989 field season as possible. For our planning purposes we have assumed that there will be at least 50 study site to choose from and that they will be scattered throughout the Arizona range of the species.

2. Assemble and Instruct Field Crews

Robert H. Perrill, the Arizona Field Crew Supervisor, will be responsible for assembling the field crews and assigning field duties. The Arizona field crews will be composed of biologists and graduate

students majoring in biology. Mr. Perrill will instruct the field crew members and make certain that each member understands and is capable of fulfilling his or her responsibilities.

As will be the case with the first-year studies, special employment conditions are likely to be attached to access permission on the Gila River Indian Reservation and the Tohono O'odham Indian Reservation. F.W. Reichenbacher & Associates will work with the Tribal Employment Rights Offices of the two tribes. We anticipate hiring four Indian guides from each Tribe for the duration of the studies on their reservations.

All field study assignments will be made on the basis of a four day work week. Field crew members will probably not be capable of remaining longer than four days continuously in the field.

3. Obtain Access Permission

No access permits will be necessary for studies on Arizona State Trust lands and BLM lands. Access permission will be required from Organ Pipe Cactus National Monument, Gila River Indian Community, and Tohono O'odham Nation. The same procedures outlined above for the first-year studies will be followed. Once again it is necessary to point out that despite our best efforts it may not be possible to obtain the required access permission from the Tohono O'odham. If it becomes apparent that access permission will not be forthcoming quadrats planned for the Reservation will be applied to other regions.

4. Assign Weekly Survey Tasks

The Field Crew Supervisor and Principle Investigator will establish a schedule for transect surveys by compiling a list of transects to complete each 4-day week. Each field crew should be able to complete an average of 10 transects each work week. The list of transects will be planned so as to minimize travelling time between each site. The Field Crew Supervisor will make sure he has all the maps required for each week's assignments. Many sites will turn out to be located in unsuitable habitat, such as cultivated fields. Alternative sites will be included in the assigned transect lists so the field crew will not have to stop work

to wait for additional site assignments.

5. Conduct Field Studies

The Arizona field crew will begin their studies after the summer rains have allowed the plants to grow and establish. Completion of a typical quadrat will involve the following steps.

a. Locate Quadrat Sites

We are assuming the selected study sites will be distributed so that some will represent the Great Plain and Santa Rosa Wash populations, populations found during the first-year studies, and possibly populations in the Tucson-Avra Valley. The field crew will drive to each site and locate the quadrat so as to obtain the best representation possible of the population. The Tucson-Avra Valley area population boundaries are mostly already known; the quadrat must be located so as to fall on the largest part of the population. In the other areas the population boundaries will not be known, although in the case of the Great Plain and Santa Rosa Wash the populations are estimated to cover many square kilometers, and are probably hundreds of times larger than the 1,000 acres specified for the second-year studies. The exact locations of twelve transects completed by F.W. Reichenbacher & Associates in 1986 were permanently marked and can easily be relocated. Compass bearings to nearby landmarks, referenced to features on the appropriate topographic map, and the compass orientation of the quadrat, will be obtained.

b. Mark Quadrat Boundaries

The Field Crew Supervisor will supervise the process of marking quadrat boundaries. One crew member will hold the compass at one corner while another, carrying a pedometer, will walk a predetermined straight line under the guidance of the compass holder, a third will follow him, tying surveyor's flagging tape on shrubs and trees as needed. Each corner will be marked. The quadrats will be 800 meters long and 80 meters wide.

c. Survey Quadrat

All potential habitat included within the quadrat will be searched. The field crew will line up four abreast and walk the length of the quadrat and return. When a T. macdougallii is found, all field crew members will stop their searches and focus on the plant's immediate vicinity. Each plant found will be temporarily marked with a wire surveyor's flag to facilitate an accurate count of all plants present. One field crew member will record all data, listing the plants, their age classes, the nurse plant(s), and record any additional notes on habitat, potential threats, and important population characteristics.

6. Field Crew Management

Robert H. Perrill, Field Crew Supervisor, will lead the second-year field studies. Mr. Perrill will assemble field crews of qualified biologists, arrange transportation, instruct the field crew members, conduct the surveys, record data, and make sketch maps detailing the location of each T. macdougallii found in relation to the surrounding landscape. He will assign field duties, including use of compasses and pedometers, set up of quadrats, localities mapping, and data recording.

Mr. Perrill will work with F.W. Reichenbacher & Associates Business Manager, Lari-Ann Clifford-Reichenbacher, on all business matters relating to employees compensation, acquisition of field supplies, and access problems.

7. Data Analysis - First-Year Studies

The Field Crew Supervisor will collate all data resulting from the second-year studies. This includes data sheets, miscellaneous notes, journal entries, photographs, and maps. They will make sure that all the data assembled is legible and accurate.

Mr. Reichenbacher will analyze all data as described in the previous sections and will draft and prepare all maps required of the project. Data reduction and analysis will include the following:

- Lists of all quadrat sites with elevation, latitude and longitude, compass bearings to prominent landmarks, and township,

range and section.

- Mean and standard deviation of the number of T. macdougalii plants per quadrat.
- Mean and standard deviation of the number of T. macdougalii plants in each age-class.
- Tables listing nurse plant associations of T. macdougalii.
- A map at scale 1:1,000,000 showing all second-year quadrat study sites.

C. Final Deliverables

Principle Investigator, Frank Reichenbacher, will be responsible for assembling, preparing, and submitting all project deliverables. These will include the following items.

1. Maps

Mr. Reichenbacher will be responsible for preparing all maps called for as contract deliverables. These will include the following.

- Transect and Quadrat Locations: two sets of paper copies of USGS 7.5 or 15 minute (1:24,000 and 1:62,500 scale, respectively; whichever largest scale is available) showing locations of first-year transects and second-year quadrats with locations of prominent landmarks from which compass bearings were taken. The first-year transects on which T. macdougalii plants were found will be highlighted.
- Sonora Transects: two sets of paper copies of Mexican (Comision de Estudios del Territorio Nacional), 1:50,000 topographic maps (15 minutes latitude by 20 minutes longitude) showing transect locations with locations of prominent landmarks from which compass bearings were taken and indicating on which transects T. macdougalii plants were found.
- Sketch Maps: Mr. Reichenbacher will redraft sketch maps of populations for final delivery.

2. Reports

Mr. Reichenbacher will prepare and submit all reports, to include

the following:

- Quarterly Reports: Progress reports summarizing achievements of the preceding quarter, problems encountered, and goals and objectives for the next quarter.
- Interim Report: Report on first year investigations including summary of accomplishments and conclusions, descriptions of areas surveyed, extensive discussion of project goals and methods, and presentation of results of first-year studies, including data on T. macdougallii abundance and distribution, analysis and interpretation of data. In addition, the effect of the results of first-year studies on site selection for the second-year studies and recommendations for the scope, locations, and conduct of second-year studies will be discussed.
- Draft and Final Summary Reports: These will include reduced raw data and detailed interpretations. The focus of the analysis will be to delineate, as accurately as possible, the range of T. macdougallii and its distribution and abundance within that range. The meaning of the data in terms of the conservation status of the species, the extent and variety of threats to the species observed or inferred from the data, and recommendations for future work will be treated in-depth.

3. Additional Deliverable Items

Mr. Reichenbacher will assemble and submit all additional deliverable items including two sets of legible field notes and data forms and representative color transparencies and color prints. The field notes and data forms will be legible and in order and the slides will be labelled with: (1) date, (2) photographer name and affiliation, (3) subject, (4) project title, (5) and location. A catalog of submitted color prints and transparencies will be compiled and submitted as well.

D. Project Schedule

We anticipate contract award by July 15, 1988, and are planning to commence field work by August 1, 1988. Long-range forecasts issued by the U.S. Weather Service predict that summer rains will commence at a slightly earlier than normal date, July 1, 1988, and that much of southern Arizona will receive higher than average summer precipitation. We look forward to ideal field conditions for this project.

Due to the difficulties of obtaining access permission for first- and second-year studies on the Tohono O'odham Reservation it may be necessary to reschedule first-year activities planned for the Reservation for the 1989 season. It may even be necessary to cancel plans for all activities on the Reservation and direct these resources elsewhere.

Table 3 lists our proposed schedule for project completion.

E. Safety Plan

The field crews will be conducting their operations in some of the most remote regions of North America during the most inhospitable season possible. Although radio or telephone communications between vehicles and between vehicles and cities would be ideal, the great distances involved would make this infeasible. We will hire only those people who are already familiar with the conditions and possible dangers they will encounter and they will be expected to plan their activities accordingly.

Field crews will be required to operate in pick-up trucks or four wheel drive vehicles equipped with tow chains, functional jacks, and viable spare tires. Emergency first aid kits will be supplied. The field crew supervisors will be advised of the need for meticulous attention to the need for safety considerations in the conduct of the project. High-pitched whistles, safety flares visible up to 20 miles away, and pocket mirrors for daytime and nighttime signalling will be supplied to each vehicle.

The two Mexican field crews will be required to operate closely together in order to minimize safety risks. Field crew members will be advised of the latest techniques for management of snake and poisonous invertebrate bite victims. The field crew will be told to take more water and food than is necessary for each field trip.

The field crew supervisors will prepare an itinerary summarizing each week's activities in advance and they will be required to check-in upon return. The Arizona Field Crew Supervisor will submit the itinerary to and check-in with the F.W. Reichenbacher & Associates Business Manager in Tucson. The Sonora Field Crew Supervisor will coordinate his activities with a designated office or individual at the University of Sonora.

Table 3. Proposed Project Completion Schedule -- Arizona-Sonora Tumamoc globe-berry studies, U.S. Bureau of Reclamation RFP 8-SP-32-00340.

Activity	1988	1989	1990
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
FIRST-YEAR STUDIES			
Assemble Field Crews			
Study Area & Transect Sites			
Access & Collection Permits			
Assign Weekly Survey Tasks			
Conduct Field Studies			
Data Analysis - First Year			
SECOND-YEAR STUDIES			
Determine Study Sites			
Assemble Field Crews			
Obtain Access Permission			
Assign Weekly Survey Tasks			
Conduct Field Studies			
Submit Quarterly Reports			
Submit Interim Report			
Submit Draft Report, Maps & Other Deliverables			
Submit Final Report			

RESEARCH PROJECT CERTIFICATION

Organ Pipe Cactus National Monument

After careful review, your proposed research project entitled

Tumamoc Globe-berry Studies

is APPROVED with the following conditions:

1. Provide an annual progress report, a final report, and, as appropriate, copies of theses, dissertations, and publications resulting from the research.

2. Acquire the following permits required by the nature of this project: U.S.F.W.S.

AZ Game & Fish

3. Abide by the following special conditions:

Submit copies of the above permits to this office

before collecting begins.

4. Abide by all the regulations pertaining to Organ Pipe Cactus National Monument.

Superintendent, Organ Pipe Cactus NM

Date

I agree to the above conditions:

Name

Date

(Please sign and return one copy)

United States Department of the Interior
National Park Service
Organ Pipe Cactus National Monument

N2219

TRACKING SHEET
FOR RESEARCH PROJECTS

Project Title: Tumamoc Globe-berry Studies

Researcher Name & Address: Dr. Frank Reichenbacher

12229 North 103rd Place, Scottsdale, AZ 85260

Dates of Proposed Project: _____

I. PROPOSAL REVIEW

Date

Research information packet sent to researcher: ☒

including:

- (a) "Initial Letter to Researcher,"
- (b) "Information for Researchers,"
- (c) "Research Proposal Outline," and,
- (d) if applicable, "Application for Permission to Conduct Scientific Research/Collect."

Research Proposal, and if applicable, Application for
Permission to Conduct Scientific Research/Collect, received
from researcher:

Research Proposal sent for review, as appropriate, to:

Chief of Interpretation:
Chief Ranger:
Chief of Maintenance:
Chief of Resource Management:
SOAR Resource Management Specialist:
CPSU/UA:
Western Archeological & Conservation Center:
WRO Div of Natural Resources & Research:
Peer Review Scientists:
Other:

Date

Comments received on Research Proposal from:

Chief of Interpretation:
Chief Ranger:
Chief of Maintenance:
Chief of Resource Management:
SOAR Resource Management Specialist:
CPSU/UA:
Western Archeological & Conservation Center:
WRO Div of Natural Resources & Research:
Peer Review Scientists:
Other:

If Research Proposal is rejected by Superintendent,
original letter sent to researcher either explaining
the reason for final rejection or requesting a
revised Research Proposal:

If Research Proposal is approved by Superintendent,
(a) original letter sent to researcher stating
approval:
(b) Scientific Research Permit issued to researcher, with
Special Park Conditions attached

II. COLLECTION PERMITS

If Application for Permission to Collect is rejected by
the Superintendent, original letter sent to
researcher either explaining the reason for final
rejection or requesting a revised Application for
Permission to Collect:

If Application for Permission to Collect is approved by
the Superintendent,
(a) copies of required state and federal
permits are received from the researcher:....
(b) special conditions and restrictions are
written on the face of the permit or
attached: X
(c) Collection Permit issued to researcher:..... X

State and Federal Permits obtained by researcher,
as appropriate:

Federal:

Endangered or Threatened Species Permit,
from USF&WS:
Eagle Permit, from USF&WS:
Migratory Bird Permit, from USF&WS:
Antiquities Act Permit, from WRO:
Federal Antiquities Permit, from WRO:

Federal Archeological Resources
Protection Act Permit, from WRO:.....
Assessment of Effect on Cultural
Resources, NPS XXX-Form, from WACC:.....
Other:

Date

State:

Scientific Collecting or Banding Permit,
from Arizona Game & Fish:
Management Research Permit, from AZ G&F:
Wildlife Holding Permit, from AZ G&F:
Agricultural Disease/Pest Permit:
Native Plant Removal and Transportation
Permit, from Ariz Dept of Agri &
Horticulture:
Scientific Educational Permit (native
plants), from Ariz Dept of Agri &
Horticulture:
Other:

If collecting is involved, NPS museum labels and
NPS catalog information sent to researcher: X

III. RESEARCH & REPORTS

Field research begins:

If periodic report requirements were stated in Scientific
Research Permit, reports received:.....
.....
.....
.....
.....

If periodic reports were required but not received,
reminder letter sent to researcher requesting
report:

Annual Investigator's Report Form sent to researcher in
early December with cover letter requesting report: ...

Annual Investigator's Report received: Date

If Annual Investigator's Report not received,
reminder letter sent to researcher, requesting
report:

If specimen collecting is involved and is to continue
into the new calendar year, and if:

(a) Annual Investigator's Report has been received,
and

(b) Superintendent approves new permit, then
Specimen Collection Permit reissued for new
calendar year and sent to researcher:

Researcher meets with park staff (especially
interpreters) and park volunteers to discuss
research and implications to park management:

_____.
_____.
_____.
_____.

Field research ends:

IV. FINAL REPORTS

If specimen collecting was involved, then either:

(a) prepared specimens received:

or (b) NPS Catalog information received if prepared
specimens were deposited in another
institution:

or (c) complete documentation received if specimens
were destroyed during analysis or study:

If disposition of specimens is not satisfied by either

(a), (b), or (c) above, original letter sent to
researcher requesting appropriate information or
action regarding specimens collected:

Date _____

Reports, Publications, Thesis, Dissertation received: _____

Final Research Report received (may be the same as a
 publication, thesis, Annual Investigator's Report,
 etc.): _____

If Final Research Report not received, reminder
 letter sent to researcher requesting report: _____

Final Research Report sent, as appropriate, to:

Chief of Interpretation: _____
 Chief Ranger: _____
 Chief of Maintenance: _____
 Chief of Resource Management: _____
 SOAR Resource Management Specialist: _____
 CPSU/UA: _____
 Western Archeological & Conservation Center: _____
 WRO Div of Natural Resrces & Resrch: _____
 Peer Review Scientists: _____
 Cooperating Association: _____
 Other: _____

If NPS contract research or Cooperating Association
 grant, review comments on Final Research Report
 received from:

Chief of Interpretation: _____
 Chief Ranger: _____
 Chief of Maintenance: _____
 Chief of Resource Management: _____
 SOAR Resource Management Specialist: _____
 CPSU/UA: _____
 Western Archeological & Conservation Center: _____
 WRO Div of Natural Resrces & Resrch: _____
 Peer Review Scientists: _____
 Cooperating Association: _____
 Other: _____

If Final Research Report rejected by Superintendent,
 original letter sent to researcher explaining
 the reasons for the rejection, requesting a
 revised Final Research Report: _____

If Final Research Report approved by Superintendent,
 invoice approved for payment and forwarded to
 NPS procurement officer or Cooperating
 Association: _____

Project conclusion letter sent to researcher: _____

Commission of Agriculture and Horticulture

Nº 29492

T/C-1

Phoenix, Arizona

Type-A

NATIVE PLANT REMOVAL AND TRANSPORTATION PERMIT

REF. _____

Phoenix
PLACE ISSUEDOctober 12, 1988
DATE ISSUEDDecember 31, 1988
DATE EXPIRES

This is to certify that Reichenbacher, Frank Wm. F. W. Reichenbacher & Assoc.
 Last Name First Name M.I. Business Name
 of 2739 N. La Cienega Drive Tucson AZ 85715-3530 886-4303 has
 Street Address City State Zip Phone

compiled with the provisions of Title 3, Chapter 7, Arizona Revised Statutes for the removal and transportation of Arizona Native Plants and is hereby granted permission to remove and transport the number and kind of protected plants listed below. Permittee must carry this permit during actual removal and transportation of native plants.

No. Of Plants	Type	Tag Numbers	No. Of Plants	Type	Tag Numbers
1. _____	Cholla	From _____ to _____	7. _____	Barrel	From _____ to _____
2. _____	Hedgehog	From _____ to _____	8. _____	Saguaro	From _____ to _____
3. _____	Ocotillo	From _____ to _____	9. <u>30 Tumamoca macdougalii</u>	~~From _____ to _____~~	~~no fee to no fee~~
4. _____	Century Plant	From _____ to _____	10. _____		From _____ to _____
5. _____	Joshua Tree	From _____ to _____	11. _____		From _____ to _____
6. _____	Prickly Pear	From _____ to _____	12. _____		From _____ to _____

Land in AZ where permission of landowner or agent has been obtained.

From: _____
 Legal Description County Last Name First Name

Physical Description State, public & private land in AZ - Pinal, Pima & Maricopa counties only

To: 2739 N. La Cienega Drive, Tucson
 Street Address City State

Purpose: Wholesale ☐ Retail ☐ Landscape Contractor ☐ Personal Use ☐
 Manufacturing ☐ Scientific ☒ and/or Educational ☒ Other ☐

MUST HAVE PERMIT AND LEGAL PERMISSION & US Letter from Fish & Wildlife Service on hand during transporting of cactus. no more than 30 specimens and only one specimen per new site. Each specimen will consist of flowering and/or fruiting stems not more than 2 feet long. ~~You are not authorized to collect tubers. Limited to the above species only.~~

Under the provisions of Section 3-904 (G), Arizona Revised Statutes, fees as prescribed by the Arizona Commission of Agriculture and Horticulture have been paid to the State of Arizona as follows:

_____ Regular Tags @ _____ Per Tag = \$ Non-fee

_____ Saguaro Tags @ _____ Per Tag = \$ _____

TOTAL \$ Non-fee

ISSUED BY: Diana Shields

TITLE: Director

Check # _____ Cash _____

PERMITEE

Commission of Agriculture and Horticulture

Nº 29492

T/C-1

Phoenix, Arizona

Type-A

NATIVE PLANT REMOVAL AND TRANSPORTATION PERMIT

REF. _____

Phoenix
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2. _____	Hedgehog	From _____ to _____	8. _____	Saguaro	From _____ to _____
3. _____	Ocotillo	From _____	10/19/88 amoca maddugali no fee to no fee		
4. _____	Century Plant	From _____	Bill Here it is! we just received it - it had		
5. _____	Joshua Tree	From _____	found a home on someone's desk.		
6. _____	Prickly Pear	From _____	Thank you for your patience.		

Land in AZ where permission obtained.
 From: _____ County: _____ First Name: _____
 Legal Description State, public & pri
 Physical Description State, public & pri
 To: 2739 N. La Cienega Drive, Tucson State: _____
 Street Address

Purpose: Wholesale ☐ 1 _____ Landscape Contractor ☐ Personal Use ☐
 Manufacturing ☐ Scientific ☒ and/or Educational ☒ Other ☐

MUST HAVE PERMIT AND LEGAL PERMISSION & US Letter from Fish & Wildlife Service on hand during transporting of cactus. no more than 30 specimens and only one specimen per new site. Each specimen will consist of flowering and/or fruiting stems not more than 2 feet long. You are not authorized to collect tubers. Limited to the above species only.

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_____ Regular Tags @ _____ Per Tag = \$ _____ Non-fee

_____ Saguaro Tags @ _____ Per Tag = \$ _____

TOTAL \$ _____ Non-fee

ISSUED BY:

Dwan J. Shields

9/13/88

Bill —

Enclosed are the signed sheet that accompanied your permit for O.R.T. and a copy of our FWS permit - We are waiting for the ag & hort permit - that I shall send as soon as it arrives.

Also enclosed is a copy of our Technical Proposal.

Respectfully,
Zair Richer-Sacker



United States Department of the Interior

FISH AND WILDLIFE SERVICE

POST OFFICE BOX 1306

ALBUQUERQUE, N.M. 87103

AUG 29 1988

In Reply Refer To
Region 2: FWE/TS

Mr. Frank W. Reichenbacher
F.W. Reichenbacher and Associates
Biological Consultants
2739 North La Cienega Drive
Tucson, Arizona 85715-3530

You and Robert H. Perrill are hereby authorized through December 1988, to use the Regional Director's blanket Endangered Species Permit PRT-676811 as subpermittees. The specific activities for which you are covered as subpermittees are given in this letter.

You are authorized to collect a total of up to 30 specimens of Tumamoc globe-berry (Tumamoca macdougalii) to document new localities of the species in Pima, Pinal, and Maricopa Counties, Arizona. However, only one specimen per new site may be taken. Each specimen will consist of flowering and/or fruiting stems not more than 2 feet long. You are not authorized to collect tubers.

The collected specimens will be deposited with Dr. Charles T. Mason at the University of Arizona Herbarium, and the Organ Pipe Cactus National Monument, Arizona. Dr. Mason is hereby authorized to transfer specimens to other reputable facilities; however, with each shipment he must provide the recipient with a copy of this subpermit and a letter listing the number of specimens involved in the transfer. Specimens sent to other facilities are not to be used as barter or trade. You are also required to furnish copies of Dr. Mason's reports to the Regional Director, U.S. Fish and Wildlife Service, P.O. Box 1306, Albuquerque, New Mexico 87103.

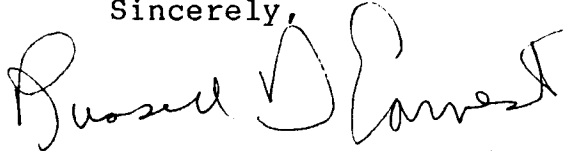
This authorization is granted under U.S. Fish and Wildlife Service Permit PRT-676811.

Please note that this subpermit is limited to the above activities and species and is functional only when used in combination with a valid State permit. This subpermit does not, either directly or by implication, allow or grant right of trespass. Such permission must be obtained from the landowner or land managing agency. Be aware that you are constrained by the stipulations on the enclosed copy of the Regional Director's permit and that you must abide by them.

A report of the activities conducted under authority of this subpermit and a request for a renewal, if appropriate, must be submitted to the Regional Director by December 1, 1988.

You must have a copy of this letter and the permit in your possession while conducting the activities authorized.

Sincerely,

A handwritten signature in dark ink, appearing to read "Russell D. Earnest". The signature is fluid and cursive, with the first name "Russell" and last name "Earnest" clearly distinguishable, and a middle initial "D." in between.

Deputy Regional Director

Enclosures

cc: Assistant Regional Director, Law Enforcement, Region 2
Field Supervisor, Ecological Services Field Office,
Phoenix, AZ
Chief, Office of Management Authority, Washington, D.C.
Regional Director, Bureau of Reclamation, Boulder City, NV
Project Manager, Arizona Project Office, Bureau of
Reclamation, Phoenix, AZ
Director, Arizona Agriculture and Horticulture Commission,
Phoenix, AZ



FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

• REGIONAL DIRECTOR, REGION 2
U.S. FISH AND WILDLIFE SERVICE
P.O. BOX 1306
ALBUQUERQUE NM 87103

Subpermittees: Frank W. Reichenbacher
Robert H. Perrill

"LIMITED"

2. AUTHORITY-STATUTES

16 USC 1539 (a)
16 USC 1533 (d)

REGULATIONS (Attached)

50 CFR 17.22
50 CFR 17.32

3. NUMBER

PRT-676811

4. RENEWABLE

☒ YES
☐ NO

5. MAY COPY

☒ YES
☐ NO

6. EFFECTIVE

12/23/87

7. EXPIRES

12/31/89

8. NAME AND TITLE OF PRINCIPAL OFFICER (If #1 is a business)

REGIONAL DIRECTOR
MICHAEL SPEAR

9. TYPE OF PERMIT

ENDANGERED/THREATENED SPECIES

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED

TAKE: WITHIN USFWS REGION 2 & IN ADJACENT STATES UPON CONCURRENCE
FROM APPROPRIATE STATE & FWS REGIONAL AUTHORITIES.
IMPORT & EXPORT: THROUGH ANY PORT LISTED IN 50 CFR 14.12 OR 14.16.

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

D. Acceptance of this permit serves as evidence that the permittee understands and agrees to abide by the "Special Conditions for Marine Mammals and Native Endangered and Threatened Species" (copy attached).

E. Authorized to conduct certain activities, as specified, with the species listed on the attached sheets for scientific research or enhancement of propagation or survival, including:

1. Actions necessary to recover specimens which will otherwise be lost because of natural processes or circumstances beyond the permittee's control;
2. Actions designated in the Service Program Advice; or
3. Actions outlined in any approved recovery plan.

(continued on page 2)

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ON REVERSE ALSO APPLY

12. REPORTING REQUIREMENTS

FIRST ANNUAL REPORT DUE 12/31/88
REPORT OF ACTIVITIES MUST BE SENT TO U.S. Fish and Wildlife Service,
Endangered Species Office, P.O. Box 1306, Albuquerque, NM 87103

ISSUED BY

R. K. Robinson

TITLE

CHIEF, BRANCH OF PERMITS, OMA

DATE

12/23/87

ORIGINAL

F. Subpermittees may be designated in writing. Upon issuance of a subpermit to any person/organization authorized to act under this permit, a copy of the subpermit should be forwarded immediately to the Office of Management Authority (OMA), P.O. Box 27329, Central Station, Washington, D.C. 20038-7329.

G. Any importation into or exportation from the U.S. of species protected under the Convention on International Trade in Endangered Species (CITES) must be accompanied by appropriate documentation under that law.



United States Department of the Interior

NATIONAL PARK SERVICE ORGAN PIPE CACTUS NATIONAL MONUMENT

IN REPLY REFER TO:

A9015

ROUTE 1, BOX 100
AJO, ARIZONA 85321

July 12, 1988

Dr. Frank Reichenbacher
12229 North 103rd Place
Scottsdale, AZ 85260

Dear Frank,

Enclosed is a collecting permit for your work within Organ Pipe Cactus National Monument to search for Tumamoca macdougali should you receive the USFWS contract. Please sign at the red "X" on page 1 and return this page (only) in the self-addressed envelope. Page 2 constitutes your permit which you must keep with you at all times when working in the park. Please read the attached conditions/restrictions before undertaking your project.

We require that if specimens are collected, draft catalog cards be filled out and submitted with the specimen coming to the park. Specimens given to another institution must be recorded with the Superintendent, Organ Pipe Cactus National Monument as well.

I look forward to obtaining a copy of your proposal. Should you need assistance during your effort here, please contact either Bill Mikus or Roy Irving (256-2983 or 387-6849).

Best wishes with your contract and subsequent work.

Sincerely,

Bill Mikus
Acting Superintendent

Bill's

United States Department of the Interior
National Park Service
Organ Pipe Cactus National Monument
Route 1, Box 100
Ajo, Arizona 85321
Phone: (602) 387-6849
256-2983

A9015

Date:

ATTACHMENT TO COLLECTION PERMIT NO. ORPI-88-14

CONDITIONS OR RESTRICTIONS

1. This permit allows the named investigator(s) researcher to collect specified objects. It is not permission to do other things which normal park visitors are prohibited from doing. For example, unless specified, the holder still does not have permission to drive off roads, dig trenches, cut or remove natural objects to make room for equipment, camp in closed areas, introduce natural or artificial objects into the park, or use firearms.
2. This permit expires on the date shown, but no later than December 31st of the year issued.
3. A new collecting permit will be issued for each subsequent calendar year of the study only after the Annual Investigator's Report for the completed year is received and reviewed by the park Superintendent.
4. The collection of specimens for use in educational programs or in the development of general study collections is disallowed in instances where specimens can be obtained outside the park.
5. Field assistants may collect specimens only under the direct supervision of the person holding the Specimen Collection Permit. The permit holder is responsible for seeing that each assistant understands the permit stipulations. Names of assistants should included on pages 1 & 2 of the collecting permit. Assistants collecting independently must be issued their own collection permits.
6. Failure on the part of the researcher to adhere to the policies outlined by the park and those policies as stipulated in the Code of Federal Regulations (CFR), Title 36, Section 2.5, and National Park Service Management Policies may result in the withdrawal of the collecting permit by the Superintendent, and the termination of research privilege in the park.
7. Special conditions or restrictions:

Submit to this office before collecting begins a copy of your USFWS & AGFD permit collect endangered species.

ANNUAL INVESTIGATOR'S REPORT

RECEIVED	
Organ Pipe Cactus N.M.	
JUN 9 '89	
SEARCHED	INDEXED
SERIALIZED	FILED
FBI - TUCSON	
Bm	

NAME OF PARK: Organ Pipe Cactus National Monument

PROJECT TITLE: Arizona-Sonora Tumamoc globe-berry Surveys

PRINCIPAL INVESTIGATORS: Frank W. Reichenbacher
(NAME/ADDRESS) F.W. Reichenbacher & Associates
2739 North La Cienega Drive
Tucson, Arizona 85715-3530
(602) 886-4303

FUNDING SOURCE/(NPS CONTRACT NO. IF APPLICABLE): U.S. Bureau of Reclamation
Arizona Projects Office
Contract No. 8-CS-32-00340

DATE PROJECT STARTED: August 15, 1988

ANTICIPATED TERMINATION DATE: October 31, 1989

RESEARCH OBJECTIVES: Document the distribution and abundance of the federally endan-
Tumamoca macdougallii (Tumamoc globe-berry) throughout its range in Arizona and Sonora.
At ORPI to determine the presence, extent, and distribution of T. macdougallii in the
Monument. Searches were made Monument-wide and in the vicinities of the two known popu-
lations at Dripping Springs and Dos Lomitas.

PROGRESS TO DATE: No T. macdougallii were found at ORPI during our 1988 surveys. Thirty-
five transects (each 1000m long, 80m wide) have been completed.

PLANS FOR NEXT YEAR: It is not known if additional work is needed at ORPI. This depends
on the outcome of negotiation for access permission with the Tohono O'odham Nation.
Would like to schedule a 5-day visit by the field crew for some time during the period
Aug. 1-Oct. 31, 1989, in the event that additional work at ORPI is desired.

REPORTS AND PUBLICATIONS PRODUCED: Enclosed

SUBMITTED BY: Frank W. Reichenbacher

DATE: June 6, 1989