GRASSLAND WATER DISTRICT LAND PLANNING GUIDANCE STUDY

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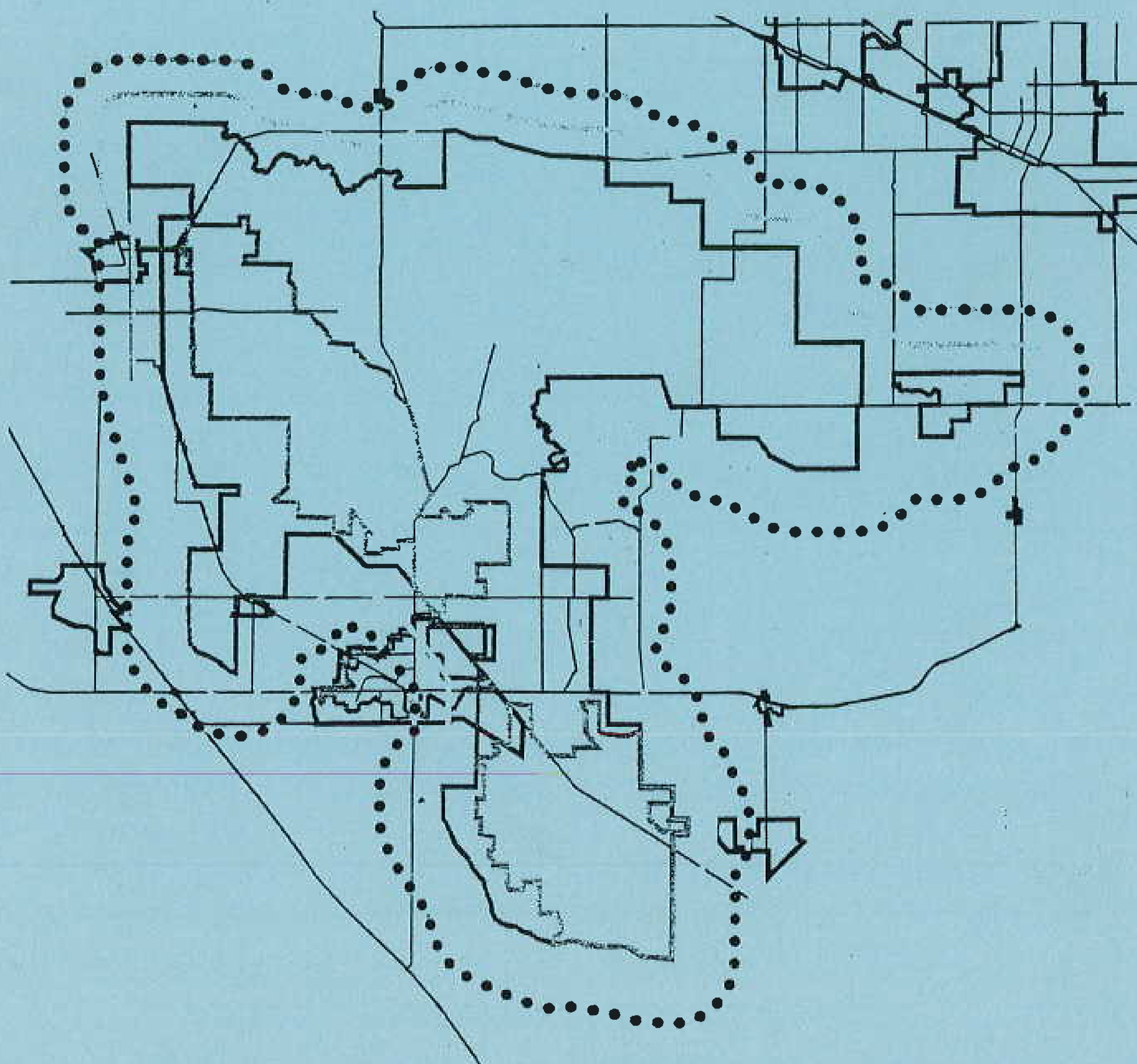
Prepared for
Grassland Water District

Prepared by
Thomas Reid Associates



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Introduction

The wetland ecosystems of the Grasslands Management Area, known as the most valuable of the remaining wetlands in the Central Valley portion of the Pacific Flyway, are endangered by development and other human activities on surrounding and adjacent lands (Frederickson and Laubhan 1994). Like many semi-natural areas embedded in human-dominated landscapes, the Grasslands Management Area is threatened more by cumulative impacts that cross its boundaries and fragment its continuity than by outright destruction (Map 1, page 21).

The Planning Guidance Study identifies:

(1) Immediate, critical threats to wildlife habitat and steps needed to protect the habitat, and

(2) Long-term threats to habitat and programmatic mitigation that should be used to address these threats.

I. IMMEDIATE CRITICAL THREATS

The most immediate, critical threat to the integrity of the habitat is the urban expansion of the City of Los Banos to the east, which would effectively isolate the southern portion of the wildlife refuge from the northern portion (Map 2, page 22). An important first principle of conservation planning is to prevent the fragmentation of habitat. A second important principle is to maintain links between habitat patches for connectivity facilitating species dispersal and migration. The major area of connectivity between the north and south wetland habitats is also the area in which a number of pending and/or approved projects are being considered. Sound conservation planning would require that this area be maintained as a permanent wildlife corridor between two major habitat areas and that development plans be discontinued.

A. Biological Issues

The proposed Los Banos General Plan will have potentially adverse impacts on sensitive wildlife, including listed threatened species. Specifically:

- the proposed expansion of urban land uses at the eastern end of the city between the San Luis Canal and the Santa Fe Canal may affect waterfowl and shorebird utilization of both the north and south Grasslands by interfering with bird population movements in the corridor area between the two refuge areas. Any development to the east of the Santa Fe Canal will likely have an adverse effect on bird movements.

- road development along the San Luis, Santa Fe or other canals could result in take of a federally listed threatened species, the giant garter snake

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- there are recent sightings of the San Joaquin kit fox, a federally listed endangered species, along Highway 152, reported by the California Department of Fish and Game.

Waterfowl and Shorebird Movements

Several studies, as summarized below, have recently documented the importance of this corridor to bird movements.

1) Fleskes data on pintail movements (Map 3, page 23):

A 3-year study (1991-94) of survival, habitat use, and movements of female northern pintail ducks wintering in the San Joaquin Valley was conducted by Joe Fleskes with the National Biological Service, California Pacific Science Center, Dixon, California. Each year, 120 to 180 female pintails were captured, radio-marked and released during August and September. Day and night locations of these ducks were determined by triangulation from truck-mounted directional antennae.

During the pre-hunting season, pintail distribution generally reflected and shifted according to the amount of available flooded habitat. For instance in 1991, early pintails were primarily concentrated on private wetlands in the South Grasslands and Volta Wildlife Area but moved to North Grassland clubs in early October as they became flooded. Day and nighttime locations during this period were often in the same or adjacent wetland.

During the hunting period, the pattern changed. Most pintails were located on National Wildlife Refuge and State Wildlife Area sanctuaries on hunting days (Wednesdays, Saturdays, Sundays) and flew to private wetlands in the evening. On non-hunting days, some pintails remained on private wetlands and some returned in the morning to sanctuaries. Most pintails present at Merced NWR during the day either remained there at night or flew to South Grassland duck clubs. In contrast, almost all pintails present at San Luis NWR and Los Banos WA flew to duck clubs in the evening. Most flew to North Grassland duck clubs, but flights to South Grassland clubs peaked during late November. There were three major morning and evening flight routes:

1) East-west between San Luis NWR/Los Banos WA and North Grassland duck clubs;
2) North-south movements between San Luis NWR/Los Banos WA/Merced NWR and South Grassland duck clubs;
3) Dispersal from Kesterson NWR to surrounding North Grassland duck clubs.

These data indicate the extreme importance of the corridor connection between the north and south grassland duck clubs in the daily movement of waterfowl through the GWMA. While many other species of ducks, geese, swans, raptorial, upland, shore and wading birds are found in the habitats of the GWMA, pintails are one of the dominant species among the waterfowl component.

There is no quantitative information as to the effect the imposition of urban use would have on current flight patterns, or what proportion of the ducks would selectively fly over wetland, agriculture or other open ground which could provide a landing place. Given the extensive movements now occurring, it is likely that a major urban development east of Los Banos could disrupt the current movement pattern, and cause a diversion of many of the birds to avoid flying over the development.

2) Harvey and Stanley bird movement data re: Pajaro Vista site

Harvey and Stanley recorded movements of up to 6,000 shorebirds and waterfowl per hour in the north-south direction between the City of Los Banos wastewater ponds and the South Grasslands. Many of these were concentrated over the site of the Pajaro Vista project (see map). East of the Pajaro Vista site, bird movements were generally lower, ranging from 18 to 200 birds/hour.

Giant Garter Snake Impacts

The giant garter snake (*Thamnophis gigas*) was recently listed as threatened (1992) by both the state and federal governments (Map 4, page 24). The snake is a semi-aquatic species which uses canals as well as natural waterways for dispersal, feeding and escape from predators. The snakes crawl up on grassy banks and other sites above the water line for basking. If there is a traveled roadway within about 200 feet of a canal, the animals will use it as a basking site and major mortality from vehicular traffic is the result (Hansen and Brode, 1992)

Recent reconnaissance by George Hansen confirmed that viable garter snake habitat exists along both the San Luis and Santa Fe Canals. According to Hansen, there are potential supporting habitats (in the form of wetlands, grasslands, vegetated canals and drains) dispersed throughout the GWMA. North of Highway 152 these include the San Luis Canal, the Santa Fe Canal, and other existing vegetated canals and drains within USGS Los Banos topographic Map T 10S R 11E sections 16, 17 and 18, which presently run through agricultural lands, and other wetlands further north. South of Highway 152, natural or restored wetlands, irrigated pasture, drains and canals form a block of potential supporting habitat for giant garter snakes within the Los Banos USGS quad sections T 10S, R 11E 19, 20, 21 and 22 and extending further south.

Urban development such as the low-density and medium-density residential development to the west of the San Luis Canal will also adversely affect the giant garter snake population. The snake can be impacted by human disturbance, domestic pets (especially cats) and water pollution in runoff. The GGS is particularly sensitive to the effects of oil and grease which destroy the insulating properties of its skin and scales. Human disturbance includes collecting and killing the animals, trampling vegetation, littering and dumping, and killing the prey base (e.g with chemicals). Garter snakes are hunted by house cats.

San Joaquin Kit Fox Impacts

Impacts to the San Joaquin kit fox from continued urban growth include increased road kill mortality, loss of foraging habitat and denning sites. In addition, CDFG have documented young kit fox being attacked by bands of domestic dogs.

B. The Buffer Concept

With respect to the GWMA, there are two scales on which a buffer needs to be considered: (1) a buffer on the east side of the City of Los Banos which will protect the resources in the corridor between the North and South Grasslands and (2) the buffer around the entire Grasslands Wildlife Management Area which will effectively insulate the GWMA in the long-term from future encroachment of urbanization or other non-wildlife-compatible uses. This latter buffer concept is further discussed below under Means to Address Long Term Threats.

1. What is a "Buffer"? The applicable dictionary definition of buffer is simply "something that serves as a protective barrier." When this definition is applied to land use planning and conservation biology, the concept must be expanded to encompass a range of conditions and meanings. The purpose of a buffer is to protect a species and/or community of concern within a protected area from adverse effects that are caused by non-compatible land uses adjacent to or near the reserve.

To adequately protect a species or community of concern from adverse effects one needs to consider the behavior of the species of concern with respect to the outside environment, and separately, the effect of the outside environment on the species of concern within the reserved area. The combination of these two distinct sets of effects independently contribute to what constitutes an effective buffer.

For example, with respect to the giant garter snake (GGS), the life habits of the garter snake determine the need for a buffer in the following manner. The GGS is one of the federally listed endangered species which occurs in the study area, the species is dependent on water channels (e.g. canals) for short-term escape from predators and for dispersal. The species will crawl up a grassy bank next to a canal to bask as part of its thermoregulation. Giant garter snakes have been observed numerous times to crawl as far as 200 feet laterally from a canal, but rarely, if ever more than 300 feet (G. Hansen, pers. comm.). If there is a road within the 200 feet, this will preferentially attract the garter snakes as a basking site, and if the road is more than very lightly travelled, then the probability of the snakes being killed by vehicular traffic is high. Therefore, from the point of view of snake behavior, to be effective a buffer must not contain a public road within 200 to 300 feet of the nearest garter snake habitat (e.g. the canal).

From the point of view of incursions into the habitat from the outside, if there is urbanization close to habitat, or access to habitat areas, then the snake can be adversely impacted by human disturbance, domestic pets (especially cats) and water pollution in runoff. The GGS is particularly sensitive to the effects of oil and grease which destroy the insulating properties of its skin and scales. Human disturbance includes collecting and killing the animals, trampling vegetation, littering and dumping, and killing the prey base (e.g with chemicals).

For these impacts, the type of barrier between land uses may be more important than the mere width of the buffer per se. For example, a residential subdivision can be separated from a wetland or canal by intervening agricultural land of different widths. If there were 200 feet of beet or alfalfa fields separating the subdivision from the nearest habitat, this might distract or discourage humans crossing to the habitat, since they would be trespassing over a farmer's field, which could be posted. If the width of the field were doubled, it would act as a greater deterrent to humans since there would be a greater distance of agricultural land to cross, and the habitat would be more distant in the view, and therefore less "attractive."

On the other hand, neither 200 nor 400 feet of agricultural land would act as much of a deterrent to cats, except that with a greater distance to cross, a cat could become distracted or decide to turn back before it encountered the habitat. However, once a cat had learned that a hunting ground existed, they would likely deliberately seek the area out irrespective of the relative distance, since house cats, both domestic and feral, have been recorded to travel many miles.

In both cases, a relatively impenetrable barrier between the habitat (canal) and the subdivision, even if only a few feet wide, could be more effective in preventing incursion of impact sources than would several hundred feet of agricultural land. For example, a strip of chicken wire between the ground and one foot off the ground, with blackberry bramble (*Rubus ursinus*) growing on top of it, could be extremely effective in preventing both humans and cats from reaching the canal, even if the blackberry bushes were only ten or twenty feet thick.

Regardless of the separation between a subdivision and habitat, water pollution in runoff from the subdivision could be prevented from reaching the habitat, if all of the runoff flowed to a drainage system which trapped and removed the oil and grease before any of the water could flow offsite.

C. Recommended Actions to Avoid Fragmentation and Impacts to "Corridor" Area

1. Overall Recommendation

The overall recommendation with respect to buffers is to use a combination of buffering techniques on different scales:

- Restriction of land uses incompatible with habitat to an area geographically west of the Santa Fe Grade, as discussed below
- A minimum 200-foot wide buffer strip of agricultural land separating any waterways from the nearest public road or urbanization
- An impenetrable barrier over several tens of feet close to habitat

2. Specific Land Use Changes Recommended for Los Banos General Plan

a. Legal Requirement for an HCP

The proposed Los Banos General Plan, or projects contemplated thereunder, are subject to federal and state permits under the respective Endangered Species Acts, and require Habitat Conservation Plans. Pursuant to the federal and state Endangered Species Acts, actions which could result in a take of listed species are subject to permits. Federal actions such as highway or water delivery system improvements involving federal funding come under Section 7 of the federal ESA, and require a consultation between the involved federal agency and the USFWS. In order for the action to proceed, the USFWS must issue a Non-Jeopardy Biological Opinion stating that the project will avoid take of the listed species or that adequate mitigation has been incorporated into the project so that the project will not adversely affect the survival or recovery of the species in the wild.

For local agency and private actions, activities in listed species habitat are subject to Sections 9 and 10 of the ESA. Take of the species is prohibited under Section 9 unless a permit is granted under Section 10(a). The permit is granted only if the proposed action incorporates a Habitat Conservation Plan (HCP) which fully mitigates the expected impacts of the project. The relevant permit on the state level is the 2081 permit.

Actions under the proposed Los Banos General Plan which could result in a take of listed species include the proposed 152 bypass and its interchanges, residential, commercial and industrial development adjacent to 152 in the eastern portion of the city, and the residential and industrial development areas designated to the east and immediately west of the San Luis Canal. Development of the college site south of the proposed bypass would be growth-inducing to the immediate area, and would thus result in both direct and indirect loss of habitat and increase in local traffic. Overall growth, and the development particularly in the eastern portion of the city would cause increased traffic levels on the existing Pacheco Boulevard, on the extension of Pioneer Road to the east, along the proposed 152 bypass, and the proposed road along the Santa Fe Canal would introduce or increase vehicular traffic along each of these transportation corridors. This traffic would in turn result in road kill mortality to both San Joaquin kit fox and giant garter snake. As mentioned above, other sources of impact include direct habitat loss, hunting, collection, predation by domestic animals, and water pollution in runoff.

The City of Los Banos may either have to prepare a citywide HCP which addresses and mitigates all potential impacts to listed species, or the General Plan must include the condition that any project within the known or suspected habitat of a listed species must obtain a 10(a) permit subject to an HCP prior to approval.

The preparation of an HCP, and USFWS processing of an 10(a) permit application are difficult, expensive and time-consuming processes which will significantly delay the implementation of projects under the new General Plan.

b. Avoidance of an HCP

In order for the City of Los Banos to avoid the need for endangered species take permits, we are proposing an alternative to the General Plan which is designed to avoid *a priori*, the majority of impacts to listed species in the area east of the city. In addition, these proposed changes would offer a major land use transitional area that would permanently buffer the threatened or endangered species, waterfowl and shorebirds in the wetlands east of the Santa Fe grade from the effects of future urban growth in Los Banos. The changes we are proposing are described below and shown on the attached map (Figure 1).

The alternative General Plan configuration we show would constitute an environmentally superior alternative under CEQA. We suggest that either the General Plan be revised to incorporate these changes as part of the Proposed Project, or that this alternative be studied in detail in the Draft EIR as part of the environmentally superior alternative.

In identifying what these changes should be, we define three categories of impact of land use on birds and other wildlife: resource beneficial, resource neutral and resource negative.

Resource beneficial means that land uses in the area should directly benefit the species of interest by providing food, shelter and other habitat requirements, and should minimize or eliminate all sources of adverse impacts to the species. Resource beneficial land uses include natural wetlands, uplands, managed duck clubs, irrigated pasture and some types of cultivated agriculture, such as rice.

Resource neutral means land uses that may or may not provide a direct benefit to the species of interest, but do not create adverse impacts to the species, and act to buffer the resource beneficial areas from the effects of urban uses. Resource neutral land uses are primarily cultivated agriculture.

Resource negative uses are uses which have little or no habitat value to the wetland-dependent species of interest, and result in adverse impacts to the species. Resource negative uses encompass most urban uses, including residential, commercial and industrial, as well as developed parks, bicycle trails, and golf courses.

In general, as shown on the attached map (Map 5 & 6, pages 25 & 26), we are recommending that all uses east of the Santa Fe Grade should be resource beneficial; between the Santa Fe Grade and the San Luis Canal, all uses should be resource neutral, with an additional buffer of at least 200 to 300 feet to the west of the San Luis Canal, specifically for the giant garter snake.

The specific changes we are proposing for the Los Banos General Plan are as follows:

a. The area proposed to be zoned I industrial between San Luis Canal and Santa Fe Grade (Map 6, page 23) should be rezoned to agriculture (AG). This would have the effect of protecting giant garter snake habitat in the Santa Fe canal, and buffering the lands east of the Santa Fe Grade from the nearest urban uses in Los Banos.

b. A 200 to 300-foot additional buffer strip of agriculture should be provided on the west side of the San Luis Canal, within the area proposed to be zoned LD. The area immediately adjacent to the canal should be planted with impenetrable hedgerow vegetation (e.g. blackberries) to reduce human and domestic animal access to the canal habitat and the GGS.

c. There is ample land south of the Highway 152 bypass and west of the corridor area that could be rezoned I to compensate for the loss of the I acreage east of the San Luis Canal, without any loss in I zoned area. This would have the effect of leaving a resource neutral use between the San Luis and Santa Fe Canals.

d. Frwy 152 bypass in the east part of Los Banos should be moved 200 feet to the west to move this away from the San Luis Canal to reduce impacts to the GGS.

e. To reduce road impacts to the GGS and kit fox, the proposed freeway interchange at the Pioneer Road extension should either be eliminated or re-designed to serve only the area west of the Highway 152 bypass.

f. All development east of the Santa Fe Grade should be eliminated to protect the contiguity of the north and south Grasslands. The area should be designated for permanent resource-beneficial open space uses.

g. No new roads should be built or improved adjacent to the Santa Fe Grade or other canals to protect habitat for the Giant Garter Snake. The proposed major roadway along this canal should be eliminated.

i. To reduce road impacts to the kit fox and preserve the resource neutrality of this zone, the proposed major roadway that would be an eastward extension of Pioneer Road into the Ag zoned area is growth-inducing, and should be eliminated.

j. The College site currently designated south of Highway 152 and the proposed bypass should be moved to outside the sensitive corridor area east of Los Banos. One option that could be explored is a land swap that could be negotiated with the California Department of Fish and Game.

k. The stormwater flow from the City of Los Banos which is discharged into the San Luis Canal must be treated or pre-treated by source control to prevent heavy metals, oil and grease from entering the canal.

c. Consider "Compact Growth Alternative"

The City of Los Banos needs to consider compact growth instead of expansive growth. The proposed new General Plan defines several growth zones around the city larger than the existing City Limit, including the Urban Limit Line, the Sphere of Interest and the Urban Influence Boundary Line. These areas are much larger than the existing city, and the NOP acknowledges (p. 5) that for example, the "Sphere of Interest is significantly larger than the current City Limits, and contains more land than the City is projected to need over the next 20 years."

The area that has been designated for urban uses in the new General Plan within the Planning Area Boundary but outside the existing City Limit is one and one half times as large as the area within the existing City Limit (new urban designated area 8,000 acres; existing city limit, 5,036 acres).

The projection of the land area needed for growth to the year 2020 shown on p. 6 of the NOP is based on the "calculated" growth projection, which is supposed to be the average of the last 5 and 10 year average growth, according to Valley Planning Consultants, and incorporates the 1993 "mini building boom" where the city experienced 10% growth in one year. This analysis shows that the City would need an additional 6,079 acres of land to accommodate the growth as shown on the table. Based on the acreages listed in Table 2 (p. 6) of the NOP, the 3,405 acres of low-density, 343 acres of medium density and 190 acres of high density-designated acreages would accommodate 23,305 new dwelling units (65,720 more persons), or 162 years of growth at the historic rate that prevailed between 1980 and 1992. The "calculated" growth area shown in Table 2 requires 6,079 acres, which is *2,000 acres less* than the area designated as urban in the new General Plan. Thus, even the inflated calculated growth projections do not seem to warrant the 8,000 acres proposed to be designated urban in the new General Plan.

On the other hand, we have done an independent analysis of the amount of growth that could be accommodated on vacant lands within the existing City Limit of Los Banos, based on the demographic data from Urban Research Associates, compiled for the City of Los Banos, and the existing General Plan, as shown on the attached pages copied from referenced documents. This analysis, shown in our Table 1, illustrates that about 6,600 residential units and over 8 million square feet each of commercial and industrial development could be built on vacant land within the existing city limit, without any expansion of the city into neighboring areas.

The demographic data in the attached Table 1 "Housing Trends in Los Banos and Neighboring Cities", from Urban Research Associates, showed that between April 1980 and January 1992 the number of housing units increased from 3,944 to 5,657, an annualized increase of 1,749 units in 12 years, or 146 units per year. At this rate, the remaining vacant land within the existing city limit could accommodate growth in Los Banos over the next 45 years, or well beyond both the 20 year stated planning horizon for the General Plan, and the 2020 planning horizon used for the projections in the NOP.

The rate of growth of Los Banos will be tied to the overall condition of the California economy. Indications are that the growth rate over the 1980 to 1992 period encompasses both faster and slower economic times and would be more indicative of a long-range trend than the calculated value used in the NOP. It therefore appears that the major expansion of land area as contemplated in the new General Plan may not be needed for the foreseeable future, and certainly not within the time frame the new General Plan is supposed to address.

A compact growth alternative would stipulate that infill on vacant lands within the existing City Limits, already designated for each type of use take place before there is outward expansion of the city urbanized area. The compact growth alternative would have other advantages as well. The provision of infrastructure to outlying areas is inefficient and extremely expensive. The compact growth alternative, which would eliminate the need to extend water, sewer, fire, police services and schools to outlying areas, would be far less expensive than the proposed General Plan.

d. Mitigation for stormwater discharges

Stormwater discharges can adversely affect the San Luis Canal and wildlife habitat. The City of Los Banos has a contract with the GWD to discharge urban stormwater to the San Luis Canal, which is used to supply Central Valley project water to the wetland habitat north of Hwy 152. Stormwater from the entire east side of the city is currently discharged to the San Luis Canal. The city is required to monitor both the quality and quantity of runoff in the San Luis Canal. It has been shown that during peak runoff periods the runoff can exceed the contractual limits. In addition, while the city is small and there are few industrial sources, pollutant loading is low and there is high enough dilution. However, with the contemplated growth in urban uses, pollution of the San Luis Canal by oil and grease, heavy metals, and toxics could become a problem.

Urban pollution, as mentioned, can adversely affect giant garter snake using this canal, as well as wildlife for which the canal is used to supply water. Therefore, the Master Storm Drain Plan, as part of the General Plan, should include mitigation for the impacts of pollution giant garter snake and on birds. Mitigation includes pre-treatment, heavy metals catch basins, filters for oil and grease removal, and best management practices.

e. Mitigation for Wastewater Treatment Ponds

The present and future wastewater disposal system for the City of Los Banos can have adverse impacts on wildlife. The present City of Los Banos, with a population of just over 16,000 persons and little industrial development currently utilizes a wastewater treatment plant that provides only primary treatment (grit removal and solids settling), followed by aeration in large oxidation ponds. The ponds are located in the northeast portion of the city, to the east of the Santa Fe Canal (Santa Fe Grade). Because of the preponderance of residential flow in the overall wastewater stream, there has not been a problem with toxics or heavy metals. However, the few industrial sources entering the wastewater are not required to pretreat their wastewater, and have contributed a high biochemical oxygen demand (BOD) to the waste stream (M. Teague, pers. comm.)

Large numbers of waterfowl and shorebirds have been observed on the ponds, which they use for resting and feeding. At present there is a concern on the part of the GWD and other resource agencies that the high concentrations of birds using these ponds is increasing the incidence of avian cholera. According to the USFWS field office in Los Banos, bird use of the Los Banos sewer ponds has been correlated with outbreaks of avian cholera among the local waterfowl populations. Mortality of Aleutian Canada Goose, a listed endangered species due to avian cholera, has been linked to the use of sewer ponds by this species in the northern San Joaquin Valley.

The agents in the wastewater responsible for avian cholera transmission are not completely understood, but one hypothesis being studied is that the calcium/magnesium ratio in the wastewater is favorable to the growth of avian cholera bacteria. The high densities of birds congregating on the ponds then leads to increased transmission of the disease within the bird populations.

Based on the analysis presented in the NOP for the EIR on the city's General Plan, the population of Los Banos is projected to grow from its present 16,000+ to between 40,000 and 60,000 by the year 2020. In addition, areas of the city are designated for commercial, commercial manufacturing, light industrial and industrial uses. The growth in population will increase the wastewater volume and the area needed for treatment, if the present method of sewage treatment were to continue. In addition, future commercial and industrial uses can introduce toxic components into the wastewater, such as heavy metals and chlorinated organic chemicals.

An increase in pond area would increase the surface area available to waterfowl and shorebirds, and could further increase the numbers of birds using these ponds as a resource, thereby further increasing disease risk within these populations. More significantly, the introduction of toxic components into the wastewater can pose new, more serious risks to the avian populations. Heavy metals are not removed by ordinary sewage treatment processes. Metals such as chromium, nickel and selenium are toxic to wildlife and may pose a significant health threat to the larger number of birds using the ponds.

If adverse impacts to waterfowl and other birds can be traced to the existing wastewater treatment ponds, mitigation could require the City changing to a more advanced waste treatment process that eliminated such ponds. Alternatively, if the City were to provide high-level (e.g. tertiary) treatment, then instead of oxidation ponds, the clean water could be put into percolation ponds which would both provide pond habitat for wildlife and recharge of the groundwater.

When the city's population reaches a certain size, it is likely that the Regional Water Quality Control Board will require a higher degree of wastewater treatment (ie. secondary or tertiary treatment). Possible funding sources for a new wastewater plant include local sewer connection fees imposed upon new development and loan funding from the California State Revolving Fund for Construction of Wastewater Treatment Facilities administered by the State Water Resources Control Board.

TABLE 1
CITY OF LOS BANOS
DEVELOPMENT POTENTIAL ON VACANT LANDS

CATEGORY	VACANT ACRES			
RESIDENTIAL		TYPICAL DENSITY (DU/ACRE)	DWELLING UNITS POSSIBLE	SQUARE FEET POSSIBLE
PD	142.4	10*	1,420	
Low-Density 1-7 DU/ac	830.14	5	4,151	
Medium Density 8-17 DU/ac	31.32	10	313	
High Density 18-22 DU/acre	47.9	15	718	
TOTAL RESIDENTIAL	1,051.8		6,603	
COMMERCIAL		TYPICAL FLOOR AREA RATIO		
Neighborhood Commercial	12.7	.37		204,700
Retail	4.24	1.25		230,870
General	48.33	.42		894,733
Highway Commercial	368.3	.42		6,738,122
TOTAL COMMERCIAL	433.57			8,068,425
INDUSTRIAL				
Planned	255.4	.40		4,450,090
General	191.8	.50		4,177,400
TOTAL INDUSTRIAL	447.20			8,627,490

SOURCES: Urban Research Associates. December 1992. "Demography and Economic Development in Los Banos, California. The State of the City."
City of Los Banos General Plan.

* PD-zoned areas do not have a target density. Density is negotiated and can be any of the permitted residential densities allowed under the Los Banos General Plan. In practice, PD densities, considering other PD uses such as golf courses, have resembled multi-family more than single-family densities. Therefore, we have assumed a medium-density residential figure for the PD acreage as an "average" of what could be accommodated.

The historic rate of growth in residential development between 1980 and 1992 (12 year period) was 143 units per year. At this rate, and not even including the PD category, 1,052 acres of vacant land within the existing municipal boundary of Los Banos, could, by infill, accommodate growth over the next 36 years, without annexing any additional lands to the City. This would almost double the existing number of dwelling units and population.

II. LONG-TERM THREATS

Longer-term threats to the integrity of the resource conservation district will result from land use changes near the boundary of the district which will encroach on the district. Certain portions of the District boundary are already protected by virtue of already being in federal or state ownership (Map 7, page 27) or conservation easement. Other portions lie adjacent or near existing cities and communities that are slated for long-term growth. Over a period of 10 to 50 years, outward growth of these cities and communities will eventually threaten the integrity or functioning of the refuge areas. In addition, certain non-urban land uses, such as agricultural practices that do not take into account the seasonal needs of wildlife, on the periphery of the refuge may also be relatively incompatible with wildlife utilization.

A. Lands to be Protected -- The Buffer Principle as Applied to the GWMA

From the point of view of the entire reserve, the principles of conservation biology dictate the need for an overall buffer or transitional area between the interior of the wildlife reserve itself and the nearest completely incompatible (i.e. urban) uses.

- A narrow "barrier type" buffer is not practical for an area of almost 200,000 acres

- The value of the reserve has been described in terms of the ratio of interior to "edge". Edge is the boundary where the effects from the outside environment interact with the reserve. These effects include trespass, poaching, vegetation destruction, pollution in runoff, littering and dumping, noise, glare, predation and disease introduction from domestic animals/pests, mosquito spraying, destruction of wildlife prey and food species, invasion by exotic plant species, movement of reserve animals into inhospitable habitats etc. (Meffe and Carroll, 1994).

- The greater the ratio edge to interior, the more the interior of the reserve is impinged upon by outside impacts, and the less true, protected "interior" habitat remains (see diagram).

- The effect of edge is shown by the area to perimeter ratio. A reserve with a large interior compared to edge will have a large area to perimeter ratio, while a reserve with an unfavorable ratio of edge to interior will have a lower ratio.

- The same principle regarding edge that applies to the reserve and the surroundings, also applies to the need for a buffer. According to Meffe and Carroll, 1994,

  "the boundary model encourages the creation of buffers around reserves to increase available habitat... and to decrease exposure to adverse conditions from the developed world....If the generated edge forms within a buffer rather than within the reserve, then it is an added positive feature."

The effect of a one-mile versus a two-mile wide buffer is shown by computing the area to perimeter ratio around the GWMA.

GEOGRAPHIC AREA	AREA (HECTARES)	PERIMETER (METERS)	RATIO	SHAPE FACTOR
GWMA	72,657	766,817	0.095	8.03
GWMA + 1-mile buffer	108,043	688,750	0.157	5.91
GWMA + 2-mile buffer	140,549	662,161	0.212	4.98

The rapidly increasing area to perimeter ratio is due to the change in "shape factor" of the total area inside the boundary. The shape factor is the relative amount of boundary ("edge") of the shape in question compared to the same area if its shape were a circle. A circle has the minimum ratio of perimeter to area of 1.0. The closer the area/perimeter ratio is to 1.0 the less its shape factor and the more favorable is the protected quality of the interior.

The GWMA with no external buffer has a shape factor of 8.03, meaning that its perimeter is 8 times more convoluted than a circle of equivalent area. The addition of a 1 mile buffer has reduced its shape factor to 5.91, and its effective edge or connectivity with outside influences by 26%. A two-mile buffer would reduce the shape factor to 4.98, and the effective edge by 38% from the GWMA boundary alone.

B. Effect of Likely Urban Expansion on Refuge Boundary

Using the GIS information on municipal boundaries and spheres of influence in relation to the GWMA boundary (Map 8, page 28), it was possible to determine whether the creation of a 1-mile buffer around the perimeter of the GWMA would impinge upon future expansion of the cities within the study area into their spheres of influence. The results were as follows:

SPHERE OF INFLUENCE LINE WITHIN ONE MILE OF GWMA BOUNDARY	SPHERE OF INFLUENCE LINE NOT WITHIN ONE MILE OF GWMA BOUNDARY
Gustine Volta Los Banos Santa Nella	Merced Atwater Dos Palos

Thus, within a 50-year planning period one can expect that traditional outward expansion of four of the seven existing urban communities in the study area will impinge on the wildlife area boundary, without buffer zone protection.

Using the principles developed above regarding the City of Los Banos, the overall recommendation is that all uses within the one to two mile buffer zone be *resource neutral* or *resource beneficial*, and that no *resource negative* uses be permitted by county, city or community plans within the buffer area.

C. Public Policy implementation methods

1. Economic Importance of the GWMA in the Region

The primary objective of adopting a new General Plan, and establishing spheres of influence around the existing urbanized area, is to promote the economic growth of Los Banos. Economic growth has traditionally been associated with economic prosperity. However, the rapidly escalating capital cost of providing new infrastructure, combined with the growing public reluctance of Californians to increase bonded indebtedness for public improvements, is changing the traditional picture.

The City of Los Banos is in the relatively unique situation of being located in close proximity to an immense wildlife resource area. The resource area was established by the USFWS under the authority of the Migratory Bird Treaty Act. That resource area has economic importance, by virtue of the public investment made to establish and maintain the resource area, and the monies spent in association with utilizing the resource area. The economic health of the City of Los Banos may be more dependent on long-term positive interaction with adjoining resource uses than with conventional urban development within its boundaries.

With respect to the above recommended changes to the Los Banos General Plan designed to reduce impacts to wildlife, the Grassland Water District should be recognized as an important element in the economy of Merced County, and a major contributor to the economic vitality of Los Banos itself. One example is the duck hunters, fishermen and others who purchase supplies, stay in hotels/motels, eat in restaurants etc. within the City.

Federal and state funds in excess of $41 million in 1994 dollars have been expended to acquire lands in putting together the refuges which now exist. In addition, well over $1 million is spent annually on restoration and enhancement on public and private wetlands within the Grasslands WMA. These are substantial commitments of funds whose value should be integrated into the City's and County's planning process.

Stoll (1989) estimated the total value of wetlands for recreation in California as $160 million, or $330/acre/year. For the GWMA, this would translate to $59.2 million annually for an area the size of the GWMA. A study by Loomis (1991) of the willingness of the public to pay to preserve San Joaquin Valley wetlands showed that the public was willing to pay up to $3,337 per acre to preserve wetlands, which for the GWMA would translate to almost $600 million. Table 2 is a summary of the expenditures by California residents and other participants for hunting, fishing, and passive recreation (bird watching, photography, sight-seeing etc.) in 1991. Total expenditures were over $2.6 billion statewide (USDI, 1991). The International Association of Fish and Wildlife Agencies (1994) reported that in 1991 migratory bird hunting general $129.1 million in retail sales, and including salaries and wages for an additional 3390 jobs created to serve migratory bird sporting activities, had a total economic multiplier effect equal to $281.5 million.

The area encompassed by the public and private wildlife refuges in the region vastly exceeds the acreage in any incorporated city or its sphere of influence, and undoubtedly exceeds the area of the all the incorporated cities together. Current data from the World Conservation Monitoring Centre (8/15/94) compiling the United Nations List of National Parks and Protected Areas lists 277 formally designated National Wildlife Refuges in the continental United States. For scale, the area of the GWMA would place it as the 10th largest -- in the top 4% -- among wildlife refuges (see graph, Figure 2). The GWMA is clearly among the most important on a national scale, and along with other Central Valley wetland resources, it is clearly important on an international scale. The GWMA deserves a level of protection vastly exceeding small park areas on a local level.

The scale and economic importance of the GWMA in the region must be taken into account in considering the land use objectives sought by the GWD. Merced County and its cities should consider *in economic terms*, the benefits gained by the inclusion within the county boundaries, a vast resource area. The economic benefits which accrue not only within the GWMA but to the City and County, depend on maintaining the biological integrity of the resource area. These economic benefits need to be considered in planning the future of the region, in addition to local economic objectives for conventional urban economic growth.

2. Role of the GWMA in the Public Forum

To be effective in protecting the wildlife resources of the GWMA, the Grassland Water District must establish a political presence and stature in the Merced region which equals that of any of the incorporated cities, or the County. The Grassland Water District should then be able to exert the same kind of planning authority as any of the other local agencies, including the ability to define its jurisdictional boundaries and its sphere of influence.

The City of Los Banos, for example, did not have to provide a justification for the expansion of its municipal boundary, planning area, and area of interest, except as defined in conventional local general planning law. The City of Los Banos is contemplating an urban expansion more than double the size of its urban area when there is enough vacant land within its existing core area to serve reasonably anticipated growth over the next 30 years.

Table 2 Expenditures for Hunting, Fishing, and Nonconsumptive Wildlife-Associated Recreation in California, 1991

Activities by Participants 16 Years Old and Older in California

Fishing	
Anglers	2,677,000
Days of Fishing	23,994,000
Average days per angler	9
Trip-related expenditures	$829,902,000
Food and lodging	$378,452,000
Transportation	$157,839,000
Other	$293,611,000
Hunting	
Hunters	446,000
Days of Hunting	5,211,000
Average days per hunter	12
Trip-related expenditures	$107,884,000
Food and lodging	$55,403,000
Transportation	$39,473,000
Other	$13,008,000
Primary Nonconsumptive	
Primary nonresidential participants	3,845,000
Days of participation	42,353,000
Average days per participant	11
Trip-related expenditurs	$929,358,000

Source: USDI, Fish and Wildlife Service. 1991. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, California.

The City of Los Banos claims to need this expansion area for its economic well being and to be responsive to private developer demands for growth.

The Grassland Water District has an equally strong basis for its own land use imperative -- the protection of the wildlife resources within its boundaries and its own role in the economic vitality of the region.

D. Further Research Needs

Detailed studies of species of concern in the Grasslands Management Area are also needed to establish with greater certainty the auxiliary habitat width and levels of connectivity required, and the specific types of land use in these zones that are compatible with native wildlife. Critical information includes data on home range size, movements, and habitat preferences. Additional research should be directed toward refining the concepts of resource beneficial, neutral and negative land uses as they relate to the resources of concern.

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Maps

The maps on the following pages are based on information from the following sources:

Satellite imagery (processed to enhance wetland habitat), Ducks Unlimited.

Base maps of roads and city spheres of influence, Merced Data Special Services.

General plan maps and updates and land use categories, Valley Planning Associates.

Natural Diversity Database of rare, threatened and endangered species, Natural Heritage Division, Department of Fish and Game.

Boudaries for public lands and surface water features, Bureau of Reclamation.

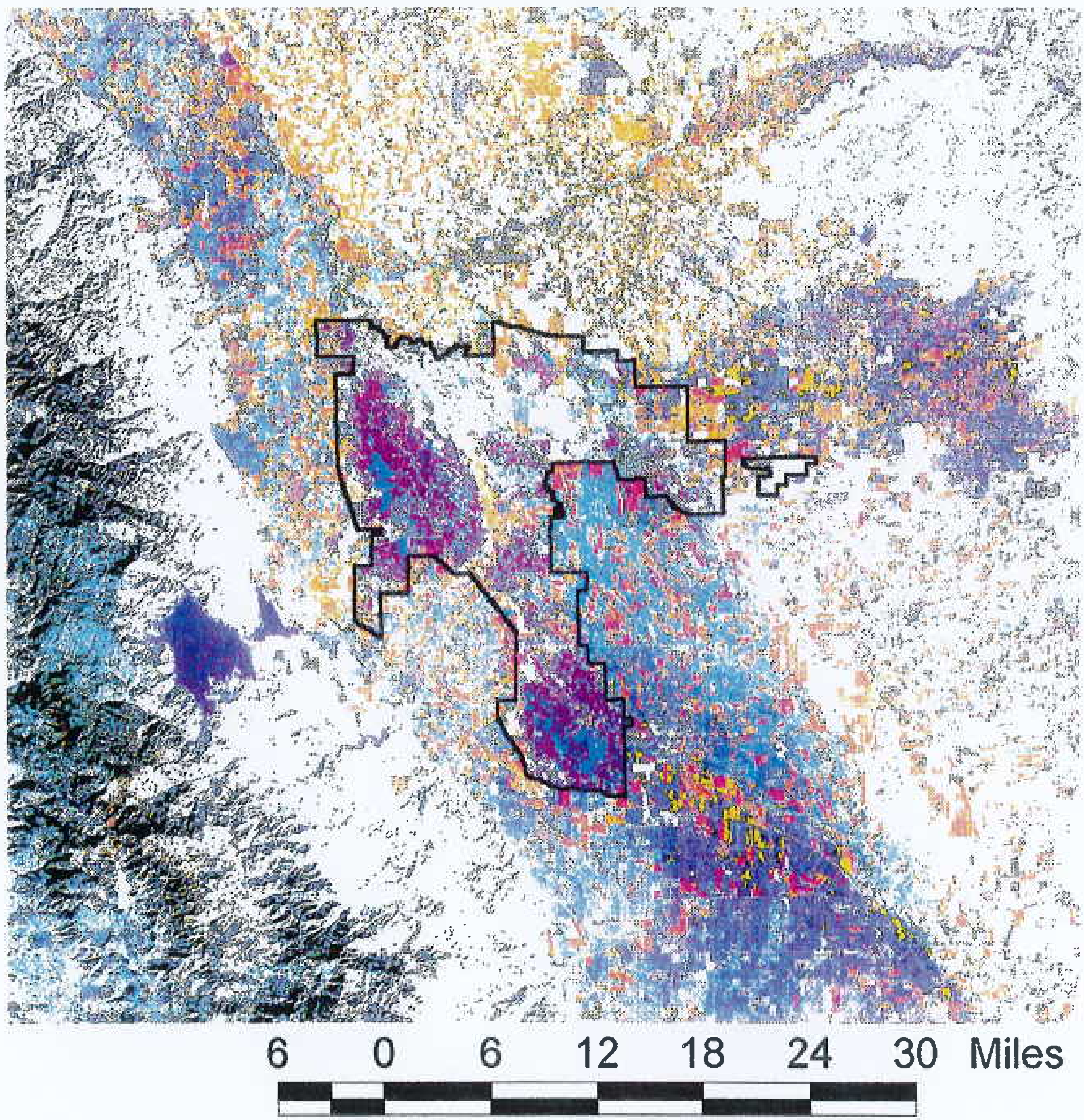
Grassland Water District boundaries, Grassland Water District.

Grassland Wildlife Management Area boundary, U.S. Department of Fish and Wildlife.

MAP 1

lgwd\map1.av 01/23/95

LandSat View of the GRASSLAND WILDLIFE MANAGEMENT AREA

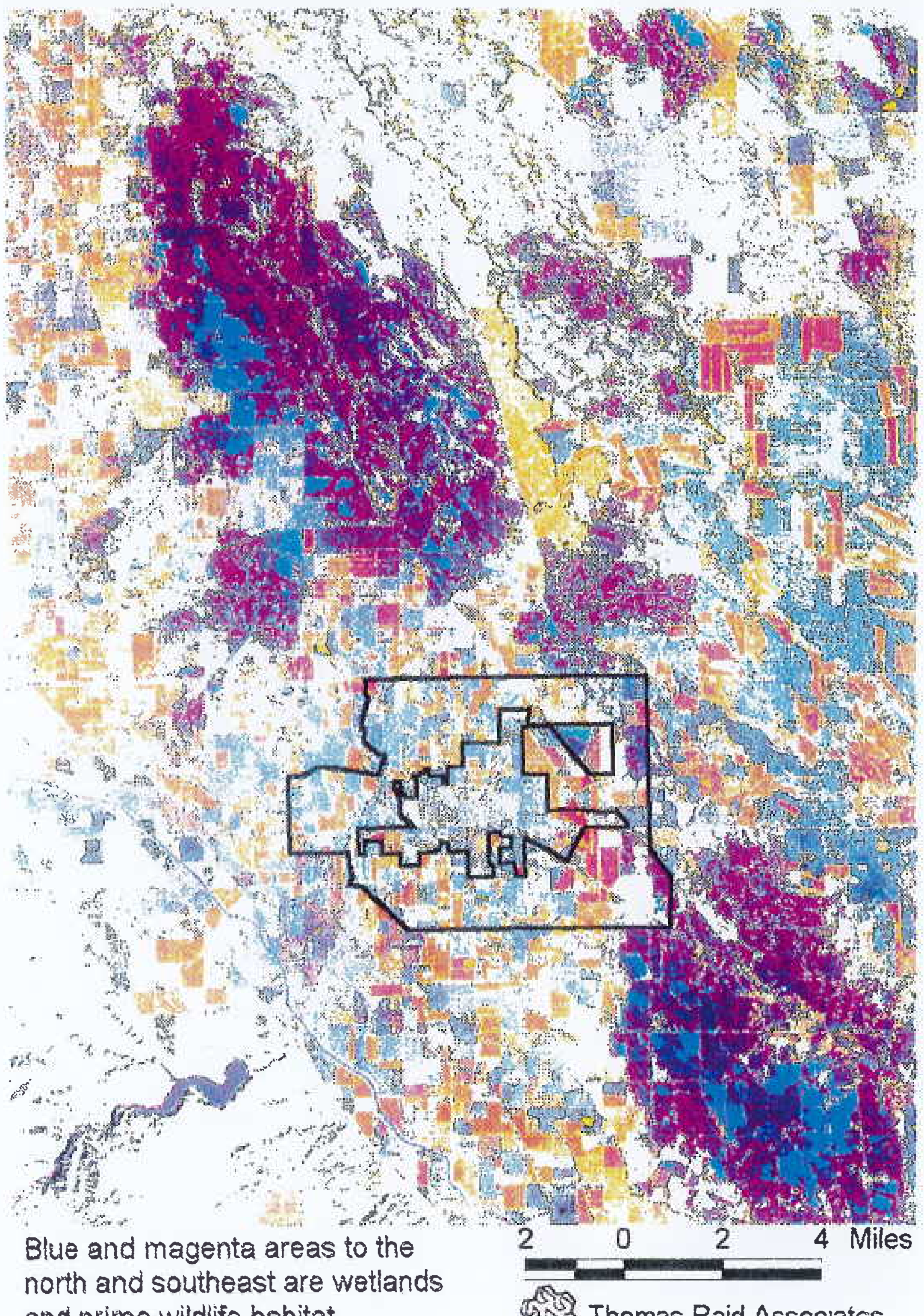


Thomas Reid Associates

MAP 2

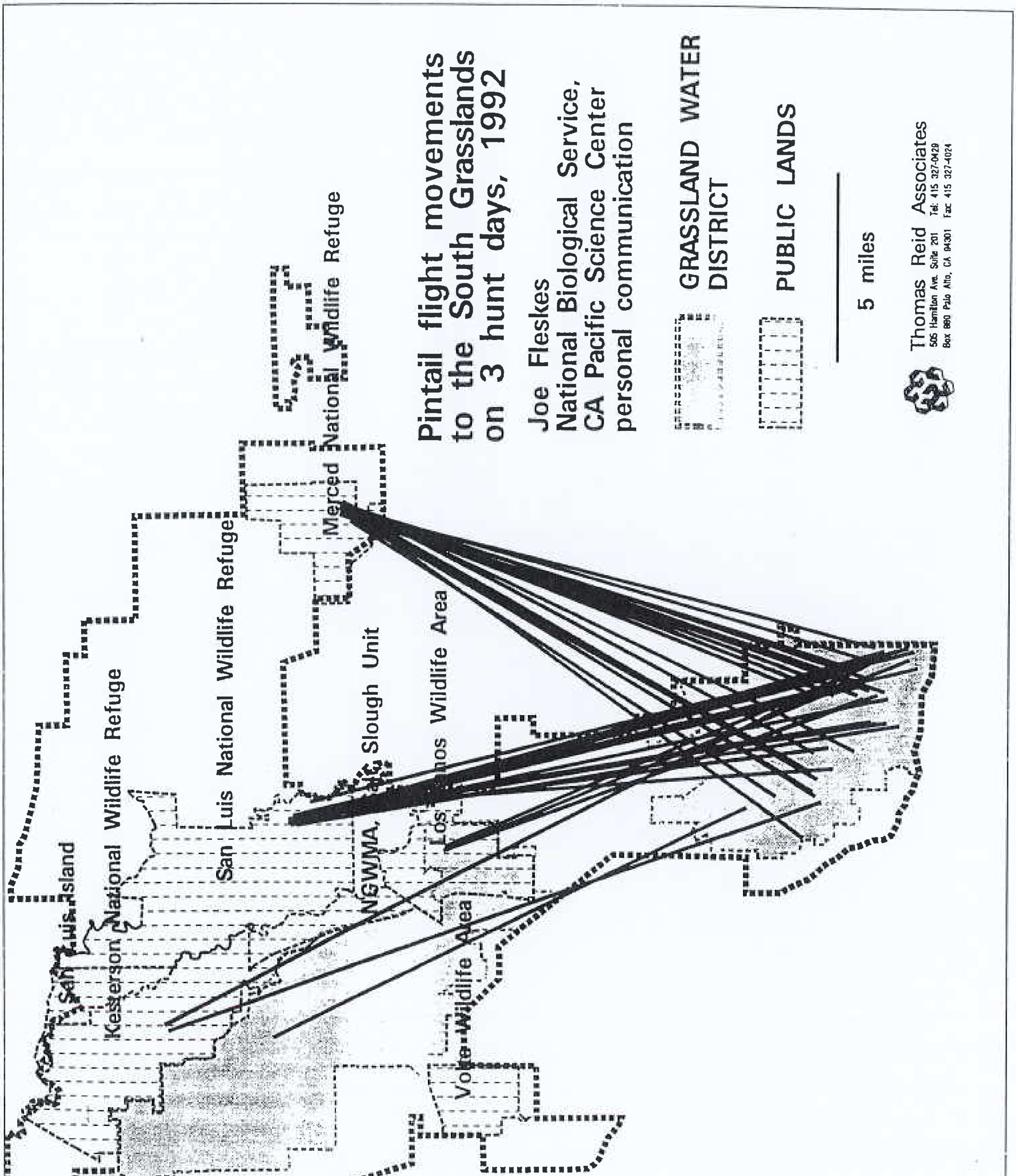
Los Banos

current city limit and proposed expansion

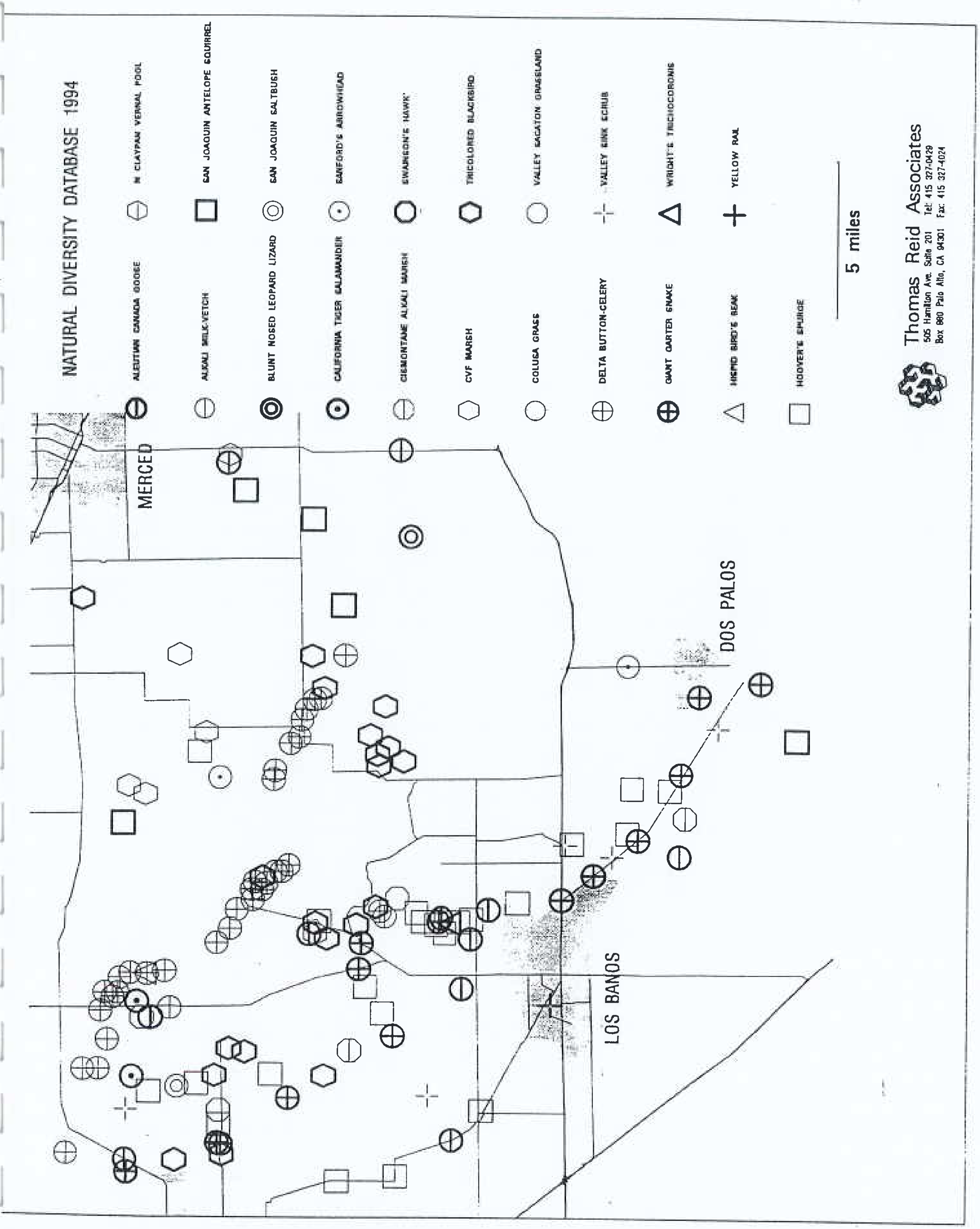


Blue and magenta areas to the north and southeast are wetlands and prime wildlife habitat.

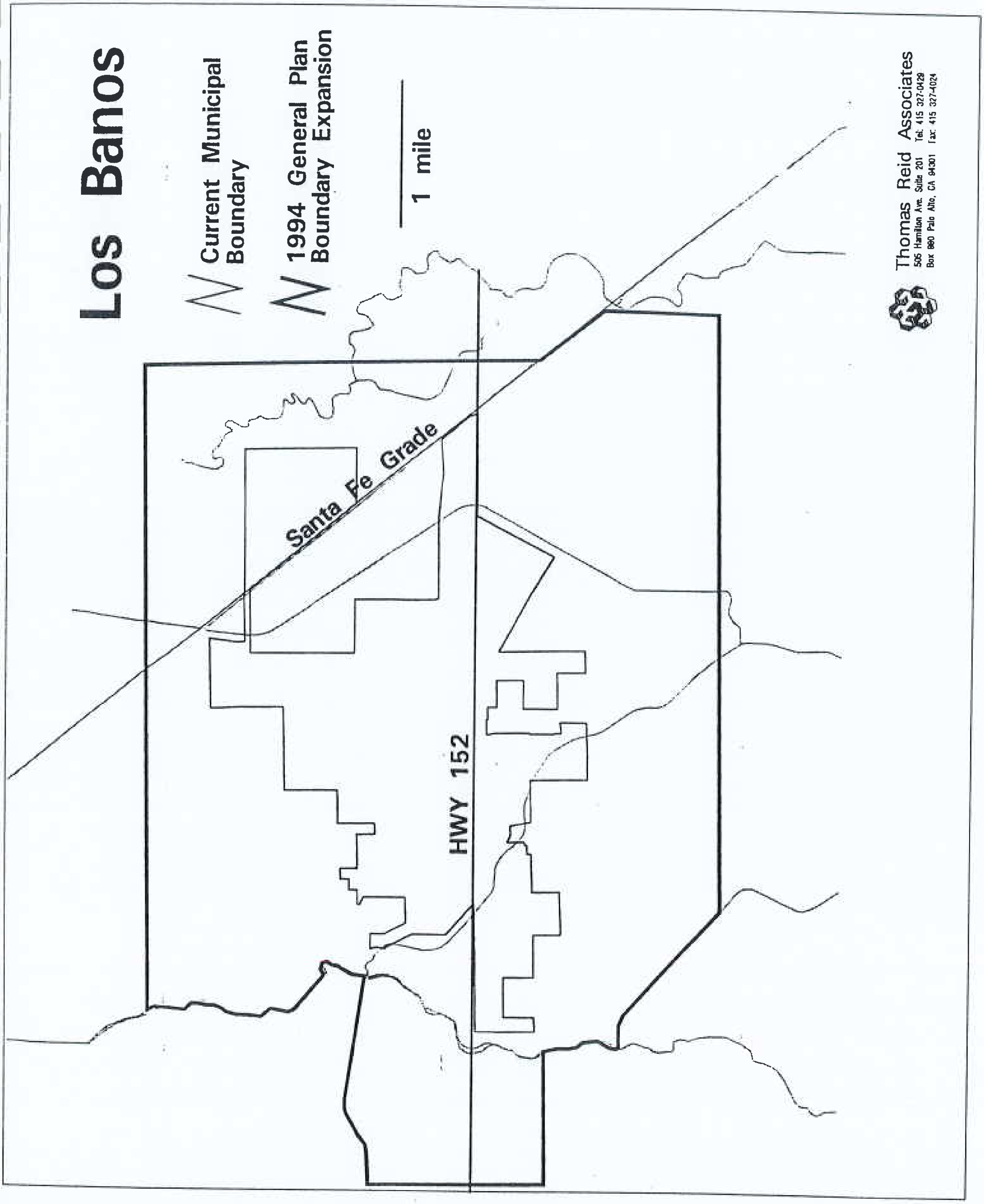
MAP 3


Pintail flight movements
to the South Grasslands
on 3 hunt days, 1992
Joe Fleskes
National Biological Service,
CA Pacific Science Center
personal communication
GRASSLAND WATER DISTRICT
PUBLIC LANDS
5 miles
Thomas Reid Associates
505 Hamilton Ave. Suite 201 Tel: 415 327-0429
Box 880 Palo Alto, CA 94301 Fax: 415 327-4024
Merced National Wildlife Refuge
San Luis National Wildlife Refuge
Kesterson National Wildlife Refuge
San Luis Island
Salt Slough Unit
Los Banos Wildlife Area
NGWMA
Volta Wildlife Area

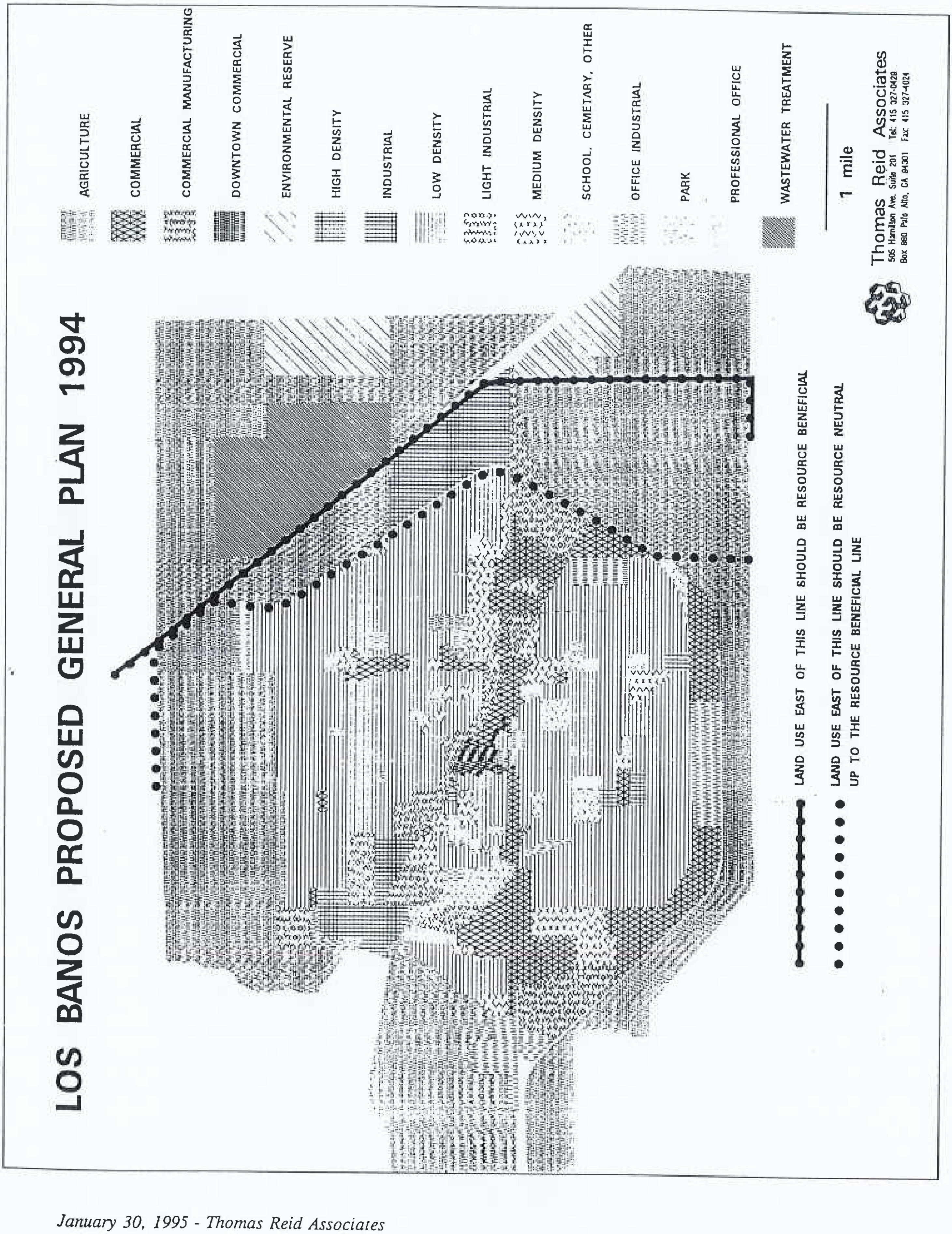
MAP 4


NATURAL DIVERSITY DATABASE 1994
ALEUTIAN CANADA GOOSE
ALKALI MILK-VETCH
BLUNT NOSED LEOPARD LIZARD
CALIFORNIA TIGER SALAMANDER
CISMONTANE ALKALI MARSH
CVF MARSH
COLUSA GRASS
DELTA BUTTON-CELERY
GIANT GARTER SNAKE
HISPID BIRD'S BEAK
HOOVER'S SPURGE
N CLAYPAN VERNAL POOL
SAN JOAQUIN ANTELOPE SQUIRREL
SAN JOAQUIN SALTBUSH
SANFORD'S ARROWHEAD
SWAINSON'S HAWK
TRICOLORED BLACKBIRD
VALLEY SACATON GRASSLAND
VALLEY SINK SCRUB
WRIGHT'S TRICHOCORONIS
YELLOW RAIL
5 miles
Thomas Reid Associates
505 Hamilton Ave. Suite 201
Box 880 Palo Alto, CA 94301
Tel: 415 327-0429
Fax: 415 327-4024
MERCED
DOS PALOS
LOS BANOS

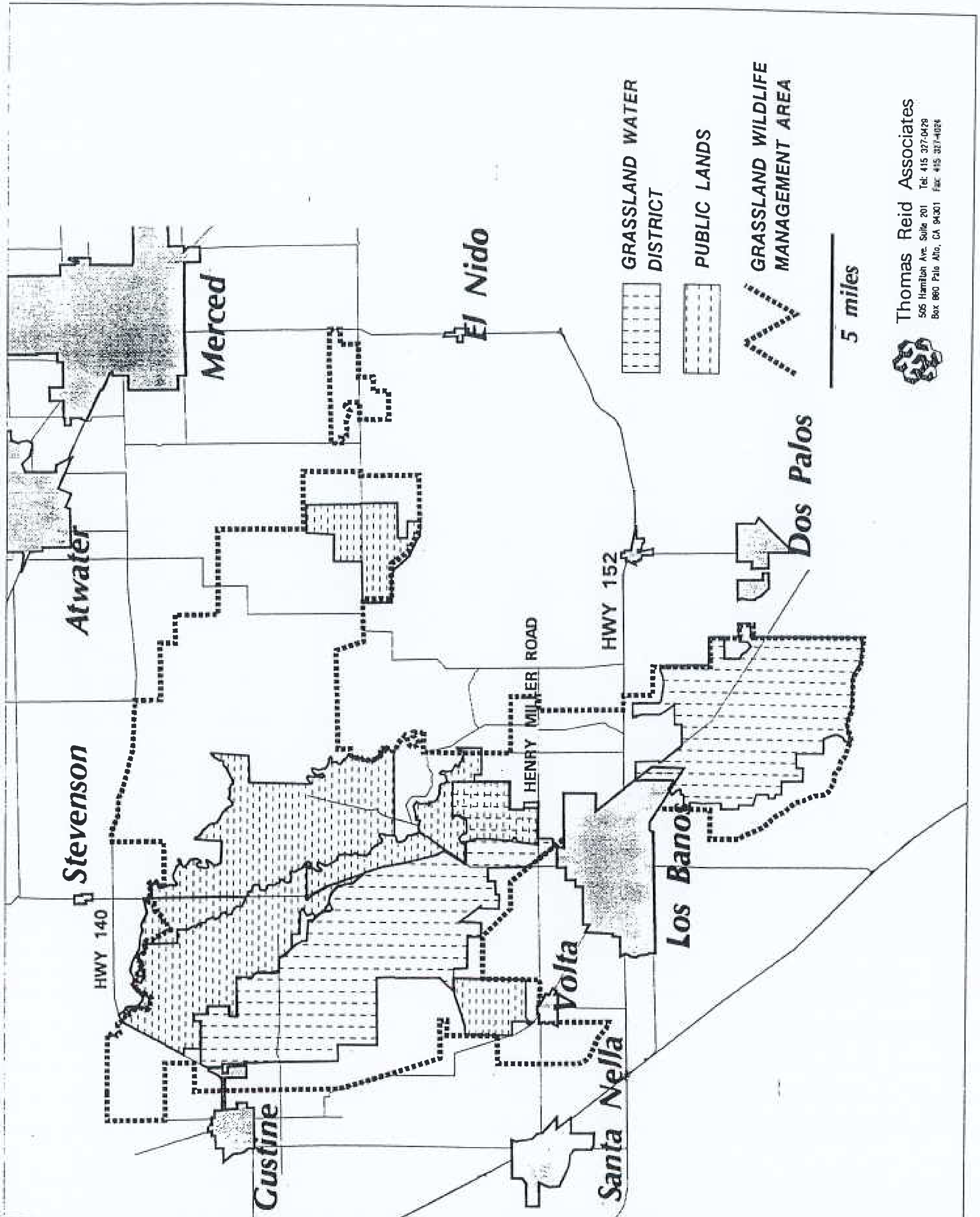
MAP 5


Los Banos
Current Municipal Boundary
1994 General Plan Boundary Expansion
1 mile
Thomas Reid Associates
505 Hamilton Ave. Suite 201 Tel: 415 327-0429
Box 880 Palo Alto, CA 94301 Fax: 415 327-4024
Santa Fe Grade
HWY 152

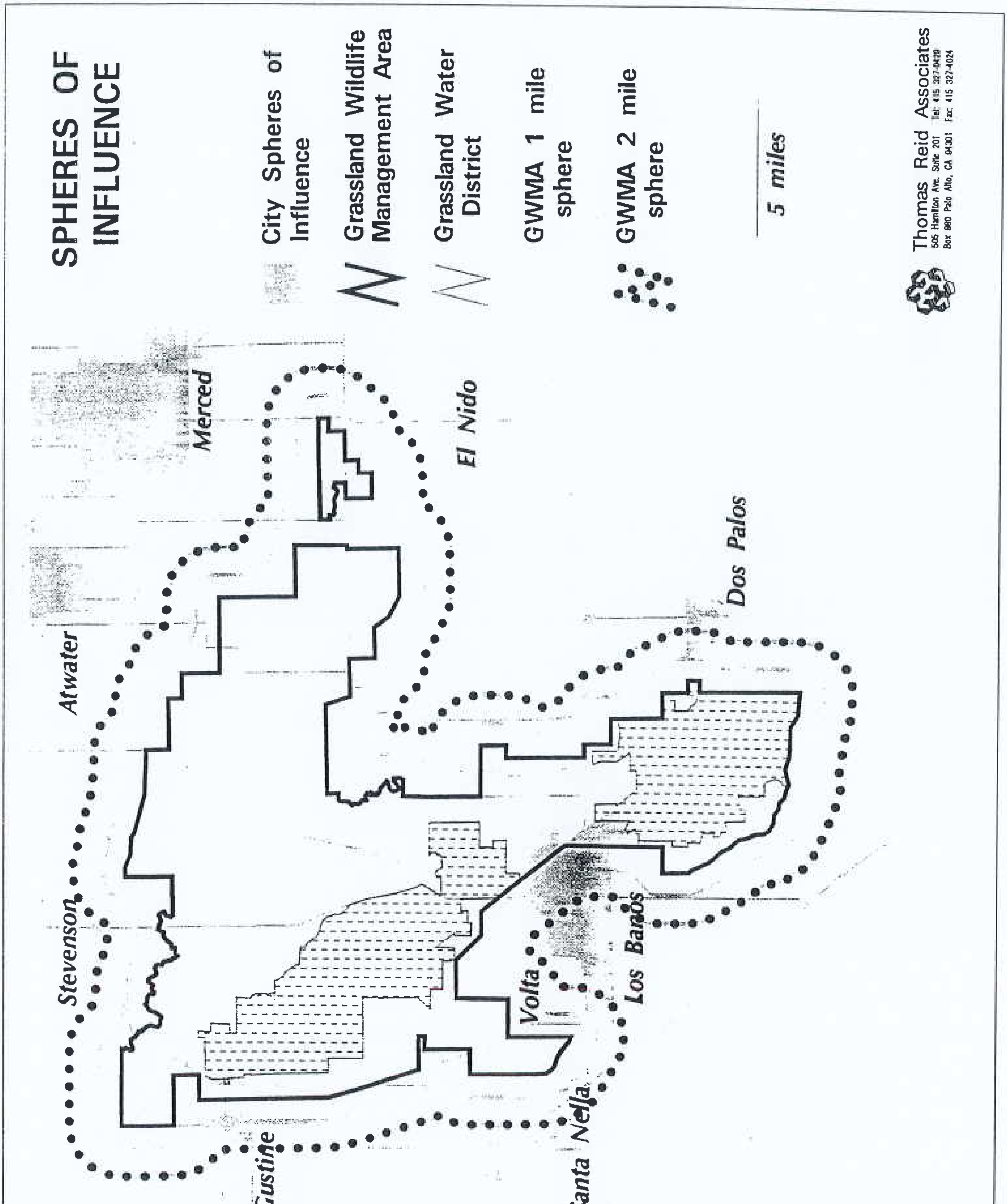
MAP 6


LOS BANOS PROPOSED GENERAL PLAN 1994
AGRICULTURE
COMMERCIAL
COMMERCIAL MANUFACTURING
DOWNTOWN COMMERCIAL
ENVIRONMENTAL RESERVE
HIGH DENSITY
INDUSTRIAL
LOW DENSITY
LIGHT INDUSTRIAL
MEDIUM DENSITY
SCHOOL, CEMETARY, OTHER
OFFICE INDUSTRIAL
PARK
PROFESSIONAL OFFICE
WASTEWATER TREATMENT
1 mile
LAND USE EAST OF THIS LINE SHOULD BE RESOURCE BENEFICIAL
LAND USE EAST OF THIS LINE SHOULD BE RESOURCE NEUTRAL
UP TO THE RESOURCE BENEFICIAL LINE
Thomas Reid Associates

MAP 7


GRASSLAND WATER DISTRICT
PUBLIC LANDS
GRASSLAND WILDLIFE MANAGEMENT AREA
5 miles
Thomas Reid Associates
Merced
El Nido
Atwater
Stevenson
HWY 140
HWY 152
HENRY MILLER ROAD
Dos Palos
Los Banos
Volta
Santa Nella
Gustine

MAP 8


SPHERES OF INFLUENCE
City Spheres of Influence
Grassland Wildlife Management Area
Grassland Water District
GWMA 1 mile sphere
GWMA 2 mile sphere
5 miles
Thomas Reid Associates
505 Hamilton Ave. Suite 201
Box 880 Palo Alto, CA 94301
Tel: 415 327-0429
Fax: 415 327-4024
Merced
El Nido
Atwater
Dos Palos
Stevenson
Los Banos
Volta
Santa Nella
Gustine

APPENDIX A.

Noss, R. F (1994) Translating Conservation Principles to Landscape Design for the Grasslands Water District.

Translating Conservation Principles to Landscape Design for the Grassland Water District

Reed F. Noss, Ph.D.
7310 NW Acorn Ridge
Corvallis, OR 97330

FINAL: May 1994

INTRODUCTION

> "Although some wetlands are significantly altered or destroyed outright by a single activity during a short time period, most large wetland systems are impacted incrementally by many sources over longer periods of time." (Witmer 1985)

The wetland ecosystems of the Grasslands Management Area, known as the most valuable of the remaining wetlands in the Central Valley portion of the Pacific Flyway, are endangered by development and other human activities on surrounding and adjacent lands (Frederickson and Laubhan 1994). Like many semi-natural areas embedded in human-dominated landscapes, the Grasslands Management Area is threatened more by cumulative impacts that cross its boundaries and fragment its continuity than by outright destruction.

The values of wetlands are now generally accepted. Thus, society has afforded them some level of protection. However, the cumulative effects of diverse land-use activities on wetlands are imperceptible to most people. But they are no less real. Mitigating those impacts requires establishment of some kind of functional buffer zone between anthropogenic disturbances and natural ecosystems. It also requires that activities that might fragment wetlands and other natural or semi-natural habitats be strictly controlled, and that high levels of functional connectivity be maintained between wetlands and other areas important to wildlife.

Buffer zones and corridors are among the best accepted concepts in conservation, but a tremendous variety of buffers and linkages has been proposed. For example, in a recent review of the literature concerning riparian buffers and their functions at local scales, Johnson and Ryba (1992) observed that 38 separate investigators recommended buffer widths of 3 to 200 meters for different site-specific functions and disturbance types. On the other hand, the buffer zones recommended for national parks and other large natural areas, as in the biosphere reserve model, are often many miles in width (UNESCO 1974, Harris 1984, Noss 1987a, 1992, Hough 1988). For the Grasslands study area of approximately 179,500 acres (Frederickson and Laubhan 1994), we can assume that optimal buffer widths lie somewhere between these extremes, that is, probably more than 200 m but less than several miles. Determining optimal buffer widths and linkages to protect wetland ecosystems requires site specific review.

We examined the literature on wetland and riparian buffers and corridors with particular emphasis on issues surrounding the waterfowl habitat and the unique pressures of various land uses in the Central Valley of California. We also reviewed the general conservation biology literature related to habitat fragmentation and connectivity. Several databases were searched for relevant journal articles and technical reports: NTIS,

SELECTED WATER RESOURCES (SWRA) DATABASE, AGRICOLA, BIOLOGY & ENVIRONMENTAL SCIENCES, WILDLIFE REVIEW, BIOLOGICAL ABSTRACTS, and LIFE SCIENCES COLLECTION DATABASES. These databases were searched for keywords and subject. Keywords and phrases searched included wetland buffers, habitat buffers, waterfowl habitat, San Joaquin Valley habitat, San Joaquin wetlands, buffer width, cumulative impacts to wetlands, wildlife management, buffer characteristics, grazing and wetland/riparian, agriculture and wetland/riparian, urbanization and wetland/riparian, and others.

FRAGMENTATION OF WETLAND HABITAT AND THE NEED FOR CONNECTIVITY

The functions and features of wetlands and riparian zones overlap considerably, especially in regions such as the San Joaquin River Valley, where most wetlands are associated with riparian zones or stream systems. Characteristics of wetland/riparian areas that are vital to their habitat values for wildlife include high productivity and diversity of vegetation, early spring availability of forage for herbivores, available surface water and associated aquatic habitats, and the continuity and connectivity of these habitats that facilitates movement and migration of plants and animals (Schroeder and Allen 1992). Activities such as livestock grazing, residential development, and agricultural practices can decrease the diversity and ecological integrity of wetland communities and make them more susceptible to domination by a single vegetation type and invasion by weedy, non-native species. These changes inevitably reduce the value of the wetlands and riparian zones for native fauna and flora. Activities that fragment wetland areas make them more vulnerable to all these impacts.

Fragmentation of natural ecosystems is widely documented to have deleterious consequences. Connectivity--in many respects the opposite of fragmentation--can help keep natural ecosystems healthy in a landscape that is otherwise highly fragmented (Noss 1987b). We discuss these two topics each in turn.

Fragmentation

Fragmentation of wetland ecosystems by human activities does not differ substantially in effect from fragmemtation of other kinds of ecosystems. Habitat fragmentation is one of the greatest threats to biodiversity worldwide (Burgess and Sharpe 1981, Noss 1983, 1987a, Harris 1984, Wilcox and Murphy 1985). Fragmentation is often considered to have two components: (1) decrease in some habitat type or perhaps all natural habitat in a landscape; and (2) apportionment of the remaining habitat into smaller, more isolated pieces (Wilcove et al. 1986). Although the latter component is fragmentation per se, it usually occurs with deforestation or other massive habitat reduction (Harris 1984). An almost inevitable consequence of human settlement and resource extraction in a landscape is a patchwork of small, isolated natural areas in a sea of altered land.

Early fragmentation studies viewed the process as a species-area problem analogous to the formation of land-bridge islands as sea levels rose since the Pleistocene. Hence, island biogeographic theory (MacArthur and Wilson 1963, 1967) was invoked to explain losses of species as the area of habitats declined and their isolation increased. Certainly, there are good analogies between real islands and caves, lakes, prairies in a forested landscape, or pieces of remnant forest in agricultural land. But there are differences, too. The water that surrounds real islands provides habitat for few terrestrial species. In contrast, the matrix surrounding habitat islands may be a rich source of colonists to the island, many of which are invasive, exotic weeds or predators on species inhabiting the island. Remnant wetlands are especially susceptible to exotic species invasion in fragmented landscapes (Ehrenfeld 1983).

Species richness does not always decline on isolated habitat patches, as predicted by island biogeographic theory. Richness may even increase (at least temporarily) as species invade from adjacent disturbed areas. In such a case, species composition often shifts toward weedy, opportunistic species while sensitive species of habitat interiors are lost (Noss 1983, Lynch 1987). The matrix in a fragmented landscape is also in a state of flux, as crops are planted and harvested, as tree plantations go through their rotations, as farming or silvicultural methods change, and as human settlements grow and decline. Thus the external environment of a habitat patch is not as constant or predictable as the water surrounding a real island.

Fragmentation is a process and ecological effects will change as the process unfolds (Wiens 1989). In the early stages of the process, the original landscape is perforated by human-created openings of various sizes, but the matrix remains natural habitat. At this stage, we would expect the abundance of native species of the original landscape to be affected little, although the access created by human trails or roads may reduce or extirpate large carnivores, furbearers, and other species subject to human exploitation or persecution. Such losses are well documented historically. Also, a narrow endemic species whose sole habitat just happened to be in an area converted to human land use would also be lost. As human activity increases in the landscape, the gaps in the original matrix become larger, more numerous, or both, until eventually they occupy more than half of the landscape and therefore become the matrix. A highly fragmented landscape may consist of a few remnant patches of natural habitat in a sea of converted land. Many landscapes around the world have followed this pattern of change (Noss and Csuti 1994).

Fragmentation does not necessarily spell extinction. A species might persist in a highly fragmented landscape in three ways (Noss and Csuti 1994). First, it might be able to survive or even thrive in the matrix of human land use. A number of weedy plants, insects, fungi, microbes, and vertebrates such as European starlings and house mice fit this description. Second, it might be able to maintain viable populations within individual habitat fragments; this is an option only for plants, microbes, and small-bodied animals with modest area requirements. Or third, it might be highly mobile. A mobile species could integrate a number of habitat patches, either into individual home ranges or into an interbreeding population. Pileated woodpeckers, for example, have learned to fly among a number of small woodlots to forage in landscapes that were formerly continuous forest (Whitcomb et al 1981, Merriam 1991). A species incapable of pursuing one or more of these three options is bound for eventual extinction in a fragmented landscape.

Besides the problem of small populations in small habitat patches being more likely to go extinct, small patches are also greatly affected by their surroundings. Sun, wind, rain, and other physical factors create a different environment near the edges of a habitat patch from in the interior, particularly for forests with relatively closed canopies. Predators, competitors, and parasites may also thrive in the disturbed habitat near an edge and penetrate some distance into the patch. Studies of birds in several regions of North America have documented increased rates of nest predation and brood parasitism by brown-headed cowbirds in forest, grassland, and wetland ecosystems fragmented by human activities

(Whitcomb et al. 1981, Brittinghman and Temple 1983, Noss 1983, 1987a, Harris 1984, Wilcove et al. 1986, Harris and Silva-Lopez 1992, Noss and Csuti 1994). Deleterious edge effects commonly extend 50-200 m into a habitat from an edge, and in some cases much farther (Noss 1983, Wilcove et al. 1986, Noss and Cooperrider 1994).

The kind of fragmentation that poses the most immediate threat in the Grasslands Management Area is development activities (for example, intensification of agriculture, housing or golf course development) that create movement barriers between units of habitat used by wildlife. As noted by Frederickson and Laubhan (1994, p. 59), "clearly species with large home ranges have very few areas of suitable size for survival. Thus, a few additional activities resulting in fragmentation will impact many more species." For example, the north and south units of the Grasslands are separated by Highway 152. Roads are known to be movement barriers to many species of small animals (see review in Noss 1993 and Noss and Cooperrider 1994). Thus, the road already fragments the wetland ecosystem. However, a small strip of habitat adjacent to Mud Slough may provide a corridor (or, more accurately, a bottleneck in a natural corridor) along which some species will travel. Aquatic species will move along Mud Slough itself. The agricultural fields to the north of the highway are probably also used as travel routes for species such as the giant garter snake (Thamnophis gigas; many records of this species in this area are in the California Natural Diversity Data Base), though they are not suitable breeding habitat.

Any further fragmentation of this vulnerable linkage between the north and south units of the Grasslands Management Area could well provide the "final blow" in fragmenting the wetland ecosystem. Importantly, fragmentation is not a black-and-white, "either-or" situation. Rather, it is a relative and cumulative problem. After some threshold of fragmentation is exceeded, movement of individuals will no longer occur regularly enough to maintain the population of a fragmentation-sensitive species. Until detailed, long-term studies of species in the study area are performed, the prudent course is to prevent any further fragmentation of the system. Indeed, professional opinion among scientists is now firm that the burden of proof in such matters must rest on those who propose activities that may fragment or otherwise degrade ecosystems.

In addition to the many negative effects of fragmentation, as documented in various habitats around the world, wetland ecosystems are likely to suffer from disruptions of water flow and other hydrological impacts that accompany fragmentation. For example, drainage canals, dikes, and roads have had severe effects on the hydrology, vegetation, flora, and fauna of the Everglades (Kushlan 1979). Similarly, fragmentation has altered flow patterns and other aspects of hydrology in the Grasslands study area, but in ways that have not been well documented (Frederickson and Laubhan 1994).

Connectivity

Connectivity--or, in particular, corridors--is a complex and contentious issue among conservation biologists (Noss 1987b, Simberloff and Cox 1987, Hobbs 1992, Simberloff et al. 1992, Noss 1993). What conservation biologists are interested in is not simply some corridor we can recognize in the landscape or draw on a map, but rather functional connectivity. Functional connectivity is usually measured according to the potential for movement and population interchange of a target species. The degree of functional connectivity in a landscape or reserve network is influenced by many factors (Table 1; Noss and Cooperrider 1994).

Connectivity is not just corridors. For species that disperse in apparently random directions, such as the northern spotted owl (Thomas et al. 1990), connectivity is affected more by the suitability of the overall landscape matrix than by the presence or absence of discrete corridors. Also, not all linkages are functionally equivalent; some, such as narrow edge-dominated corridors, may do more harm than good by serving as mortality sinks (Henein and Merriam 1990). Some kinds of corridors (for example, roadsides) also create conservation problems, such as by facilitating the spread of weedy and exotic species (Noss 1993a). But other corridors, for example, riparian systems, are well accepted as critical movement routes for many wildlife species (Harris 1984, Noss and Harris 1986, Binford and Buchenau 1983).

Viewed from the perspective of land-use planning, connectivity is basically the opposite of fragmentation. In contrast to breaking landscapes into pieces, we seek ways to preserve existing connections and restore severed connections. Preserving existing connections is almost always a good idea. As argued by Hobbs (1992), "maintenance of existing linkages should be an important component of any conservation plan, on the basis that it is easier to retain them now than to replace them in the future." Thus, as noted above, in the absence of data to the contrary, the most prudent and conservative planning decision is to prohibit any further fragmentation of an ecosystem and maintain existing levels of connectivity.

Specifying the scale of connectivity being considered in a conservation plan is critical; the spatial scale would vary depending on the scale at which the target species disperse and travel about the landscape. Narrow fencerow corridors a few hundred feet in length form an appropriate scale for considering functional connectivity for rodent populations (Merriam 1988), whereas a multiple-use landscape 30 miles wide that lies between two national parks can be considered a corridor at a regional scale, if it functions as such for wide-ranging animals (Noss 1992).

Thus, linkages within the Grasslands Water District--such as the narrow corridor connecting the north and south units--are important to wildlife at a relatively fine scale determined by local population dynamics. The connectivity of the Grasslands within the system of natural and semi-natural habitats in the San Joaquin Valley and the entire Central Valley is important at a broader scale, as determined by movements of wider-ranging or migratory species. Finally, the role of remnant wetlands of the Central Valley in the Pacific Flyway corridor is critical at a still broader scale for migratory waterfowl (Frederickson and Laubhan 1994).

In landscapes where natural corridors have been destroyed and cannot easily be restored, reserves should ideally be very close together and not separated by insurmountable barriers (Diamond 1975, Thomas et al. 1990). For species, such as many small vertebrates and flightless invertebrates, that refuse to cross roads or other relatively narrow swaths of unsuitable habitat (Oxley et al. 1974, Mader 1984, Swihart and Slade 1984, Mader et al. 1990), continuous habitat linkages are needed both for movements within home ranges and for dispersal. In many cases, roads have been elevated (i.e., underpasses or tunnels created) to allow passage of wildlife underneath (Noss 1993).

Even in the absence of distinct movement barriers, sheer distance can make successful dispersal unlikely, even for species as mobile as large mammals. Thus, reserves separated by areas of unsuitable habitat longer than normal (mean or median) dispersal distances of target species should contain resident individuals or populations between them, either distributed more or less continuously or in stepping stone habitats.

Applying basic principles of conservation biology design and considering the importance of connectivity, a reserve design model for a human-dominated region consists of core reserves linked by corridors of suitable habitat and enveloped by buffer zones (Fig. 1, adapted from Noss 1992). Riparian systems are natural candidates for corridors, as they constiture paths of least resistance through many landscapes and are often used as movement routes by wildlife (Noss and Harris 1986, Binford and Buchenau 1993). Regional networks of two or more reserves might be linked to other regions by corridors established along rivers, ridgelines, or other functionally significant natural features (Noss 1992, 1993).

As noted above, in the Grasslands Management Area the natural linkage between the north and south units has been partially severed by Highway 152; Highway 165 partially fragments the north unit (Frederickson and Laubhan 1994). Canals and other human-disturbed habitats further subdivide the area for many species. The effects of these barriers on the functional connectivity of the Grasslands for various species has not been well documented. However, a functional corridor still exists between the north and south units for many species of animals. Unfortunately, detailed data on use of this corridor by various animal species do not exist. Again, in the absence of specific data on corridor use, the prudent option is to maintain existing linkages (Noss 1987b, 1993, Hobbs 1992). Maintaining and enhancing the corridor between the north and south units of the Grassland Management Area is one of the highest priorities in managing the ecosystem.

EFFECTS OF ADJACENT LAND USES ON WETLANDS AND THEIR FUNCTIONS

The effects of land use activities on wetland systems are multiple. The problem is compounded by the cumulative nature of many pressures that are difficult to comprehend without viewing the whole picture. Agriculture currently affects more wetland area nationally than any other human activity. In the context of cumulative impacts, the major dangers to wetlands are agricultural development, urban development, and conversion of wetlands to deep water habitats. However, urbanization is rapidly increasing in importance as an impact, and most studies suggest that the effects of urbanization on a given wetland are more severe than the effects of agriculture.

Effects of livestock grazing and agriculture

Agricultural activities, including livestock grazing, affect more wetland area than any other land use in the United States (Nelson 1989). The most prevalent abuse of wetland/riparian zones in many regions is livestock grazing (White 1991). Cattle and sheep are attracted to wetland and riparian zones because of the quality of vegetation, the shade provided in such areas, and the availability of water. Grazing affects many elements of the wetland ecosystem. In general, impacts to wetland vegetation can be separated into four areas: compaction of soils (which increases runoff and decreases water availability to plants), herbage removal, physical damage to vegetation by rubbing, trampling, and browsing, and changes in the fluvial processes, which may lower the water table and cause a decline in the vegetation that thrives in wetland conditions (Kauffman 1988). Over grazing not only affects the vegetative component of the wetland, but can also increase soil erosion and alter hydrology. Like most other impacts from various land uses, the effects of grazing cascade to affect other elements of the system and reduce the overall functions and values of wetlands.

In a study of riparian habitat in western Texas, Schmidly and Ditton (1978) documented a significant difference in species composition and density of mammals between grazed and ungrazed sites. For example, the rodent fauna under grazing conditions was composed primarily of heteromyid rodents (66% of total catch) whereas representatives of this family of rodents were rare on the ungrazed sites (1.4% of the total catch).

The effects of grazing on wildlife and other ecological values in the Grasslands Water District have not been well studied. Certainly it would not be wise to intensify grazing in areas adjacent to wetlands. In many areas, reduction in grazing pressure may be required, but research is needed to determine the optimal level.

Row and truck crop agriculture also have effects on adjacent wetlands. Reduction of water quality in riverine and wetland systems is often associated with run-off from farms (Bingham et al. 1980). Agricultural run-off affects habitat structure and diversity and reduces populations of sensitive species. As Heitmeyer et al (1989) suggested, increased toxic contamination of invertebrates and seeds in wetlands may have been partly responsible for waterfowl population declines in the San Joaquin Valley. These results suggest that maintenance of healthy waterfowl populations may require either a reduction in the total amount of land devoted to agriculture in the valley, restrictions on agricultural use of pesticides and other chemicals, or both. However, an undeveloped upland buffer zone of sufficient width might help reduce flow of chemicals into the wetlands.

Between 1950 and 1970, conversion to agriculture was by far the major cause of palustrine wetland loss nationwide (Dahl 1990, Johnston 1994). Nearly 50% of mature riparian vegetation in the Sacramento River Valley was removed and converted to agriculture between 1952 and 1972 (Burns 1978). Other impacts include the increase in relative corridor length between wetlands as wetland density decreases in a valley. Johnston (1994) states that increased corridor length could have a cumulative effect and "could be detrimental to animals that traverse over non-wetland areas to use the resources of several wetlands, the increased travel length putting them at greater risk to predation by humans and other animals."

Farming in North America has a significant impact on nesting and brood rearing waterfowl (Kadlec and Smith 1992). Agriculture is in direct competition for "wet soils" that would normally be utilized by waterfowl. In addition to the destruction of wetlands and waterfowl habitat for agricultural use, the erosion and pollutant runoff associated with cultivated farming adversely effects waterfowl and wetlands in general.

Despite the documented damage that agricultural activities cause to wetlands, low-intensity agriculture certainly causes less harm than intensive agriculture. Conservation easements and other mechanisms that improve the buffering capacity of farmlands and increase their value to wildlife should be sought in the Grasslands sudy area.

<u>Urban development</u>

Urban development is widely regarded to be the land use with greatest potential impacts to wetlands (Cooke 1992). A study of wetlands in the Puget Sound area determined that the degree of urbanization surrounding a wetland is strongly correlated with the degree of disturbance to the wetland (Cooke and Conneley 1990, Cooke 1992). The more developed the basin in which a wetland complex exists, the more potential deleterious impacts there are to the wetland (Ehrenfeld 1983, Cooke 1992). Thus, wetland conservation programs must not only consider protection of individual wetlands, but must also control the extent of development throughout the watershed or landscape in which wetlands exist.

Impacts of urban development on wetlands noted in the Puget Sound study (Cooke 1992) include (1) physical disruption, such as mowing and digging; (2) chemical disruption, including inputs of toxicants and fertilizers from lawns and roads; (3) competitive disruption from introduction of nonnative species; (4) noise disruption, for example from roads and lawnmowers; and (5) visible disruption, for instance removing the tree and shrub canopy that screens wetlands. Cooke (1992) found that buffer zone functions were reduced in direct proportion to the narrowness of the buffer. Buffers less than 50 feet wide showed a 90% increase in degradation after adjacent urbanization.

In a study of wetlands affected by development as compared to pristine sites, Ehrenfeld (1983) found that the developed sites tended to lose the herbaceous species component and exhibitied a decreased frequency of shrub species. This vegetation was replaced by species from surrounding geographic regions and exotics, a large number of which were vines. The resulting areas exhibited low habitat value and were degraded because of the exotic and weedy nature of the colonizers. Urbanization changed water chemistry and flow, and drastically altered the plant and animal communities of the wetlands. "One of the most important environmental changes (in wetlands draining developed lands) is the addition of nutrients to the nutrient poor ground and surface water as a result of urbanization" (Ehrenfeld 1983).

Because urbanization usually seems to cause more damage to adjacent wetlands than do other land uses, maintenance of a buffer zone (even if in agriculture, rather than natural habitat) between urban areas and wetlands is essential. Cooke (1992) found that the effectiveness of buffers in protecting adjacent wetlands depends on (1) the number of lots adjacent to the buffer (the fewer, the better); (2) the size of the buffer (the wider, the better); (3) the type of buffer (vegetation types that act as visual screens, physical barriers to humans, sediment filters, and chemical filters are preferred); and (4) ownership of the buffer (buffers owned by landowners who appreciate the purpose of the buffer remain more intact).

Wetland buffers and their characteristics

Wetland scientists generally agree that buffers are needed to protect wetland habitats. Wetland buffers not only have the potential to insulate wetlands from adverse effects of various land use activities, but in many instances they also form unique and valuable habitat in their own right (Brown et al. 1987).

Our examination of the Grasslands Management Area suggests that the buffer concept be viewed holistically. Among the potential functions of buffer zones are the following:

1. Capture key ecological factors (rare species occurrences, key watersheds, etc.) not included in core reserve due to financial, political, or other limitations. Ideally the most valuable sites are encompassed in the core reserve, but buffer zones might include areas of somewhat lesser value (less concentrated rare species occurrences, higher road density, greater past disturbance by humans, etc.).

2. Provide supplemental habitat (for instance, for foraging) for key species inhabiting the core reserve.

3. Serve as a true buffer or filter that protects sensitive habitats and species in core reserve from disruptive human influences and edge effects originating in the surrounding matrix.

4. Protect people and their domestic animals and plants from depredating large mammals that may reach relatively high densities in core reserves.

5. Serve as suitable and safe movement habitat for animals traveling between and among core reserves.

6. Serve as areas for developing, testing, and demonstrating land-use and management practices that are compatible with conservation of biodiversity.

Buffer zones should be as wide as necessary to accomplish these objectives, or at least some subset of them. Necessary width will vary depending on several factors:

a. Size of reserve. The relationship is usually inverse, in that very large reserves may not require buffer zones, whereas small reserves are subject to intense edge effects and need buffering.

b. Type and intensity of land use in matrix. For example, a wider buffer zone is indicated if the matrix is high-density residential as opposed to agricultural land-use.

c. Types and intensities of use expected in buffer zone. If hunting, for example, is expected to be intense in the buffer zone and species sensitive to hunting occur there, the zone should be wide enough that hunters do not penetrate far into the zone from access points along its periphery.

Two or more buffer zones may be advisable in some cases, with inner zones more strictly protected (e.g., lower road density, more restrictions on agrilcultural activities) than outer zones. This is the multiple-use module idea of Harris (1984; see also Noss and Harris 1986, Noss 1987b).

The width of buffer zone needed to protect wetlands is not easy to determine and must involve site-specific analysis. Since different wetlands have different values that people choose to protect, there is great variance in the proposed buffer width among wetlands and types of disturbance. Buffer zones must remain relatively intact for a long time to function effectively (Corbett and Lynch 1985).

The most common buffer widths that have been recommended for riparian systems are from 12 to 33 meters (40-100 feet) (Corbett and Lynch 1985). Wetland/riparian buffer widths of 33 meters (100 feet) or greater may be effective in maintaining water quality depending on the disturbance types in surrounding areas (Castelle et al. 1992).

However, recent research indicates that many buffers are too narrow to protect wetlands and aquatic habitats (Binford and Buchenau 1993). In King County, Washington, the 7.6 meter (25 foot) buffers commonly established around wetlands in urban settings failed to prevent degradation of wetlands (Cooke 1992). Significant deposition of sediments eroded from agricultural fields in Maryland occurred 80 meters from a field into a riparian forest (Lowrance et al. 1988). Based on her study of wetlands in the New Jersey Pine Barrens, Ehrenfeld (1983) was convinced of the degrading effect of urbanized runoff, but saw the need for more research to determine whether conventional buffers are sufficient to prevent degradation of the wetlands. In their review of riparian corridors, Binford and Buchenau (1993) conclude that "80 to 100 meters would be a reasonable minimum range of buffer widths...if the objective were to reduce sediment load by 50 to 75 percent; wider corridors would be necessary for greater sediment removal."

As waterfowl habitats, wetland buffers should provide waterfowl nesting sites and food, and should meet behavioral requirements such as visual isolation and cover in proper configurations to avoid or reduce predation. As Kadlec and Smith (1992) note, a single vegetation type is not likely to provide the diverse habitats required by different species of waterfowl. "In describing optimum riparian habitat, we must recognize that what is optimum nesting habitat for a mallard (*Anas platyrhynchos*) is totally unacceptable for a killdeer (*Charadrius vociferus*)" (Kauffman, 1988). Hence there is a definite need for structural as well as community diversity of wetlands and their associated buffers. Habitat components that can be provided by buffers include plant species diversity, structural complexity, and shelter. Buffers can provide cover and nesting sites for those species that utilize a mix of wetland and upland areas.

In a study of Central Valley habitats, Hehnke and Stone (1978) observed that in spring and fall migrations, bird density and diversity were higher in riparian and associated vegetation than in riprapped slopes. In the same study, about 85% of the total number of birds using agricultural land were blackbirds and sparrows, which indicate a disturbed and impoverished community. Riparian vegetation appears to be the major factor controlling avian diversity and density in the Sacramento Basin. Wetlands and their associated buffers need to be productive enough to provide the 750-950 kg/ha of food necessary to support current waterfowl populations. There is some question whether the wetland resources of the Central Valley can sustain these needs (Heitmeyer et al. 1989). If riparian and wetland vegetation in the Central Valley is further modified, plant and animal diversity can be expected to decline.

Wetland size is an important factor for many species. However, wetlands of relatively small size can be useful to waterfowl and some other animal species if they are well buffered and connected to other wetlands. Sousa and Farmer (1983) estimated that the minimum habitat area for wood duck broods is about 10 acres. Wetlands smaller than 10 acres may be used when they are not isolated from other wetlands (i.e., as long as they are connected by buffered corridors). Wood ducks nest in tree cavities and need 20 acres of nesting habitat for each acre of brood rearing habitat. Sousa and Farmer (1983) suggested that buffers be established in relation to open water, specifically in a ratio 50-75% cover to 25-50% open water.

Studies of wildlife habitat use along wetland-upland ecotones provide additional guidance for buffer zone width. To maintain waterfowl habitat in wetland areas, Castelle et al. (1992) recognized the need to retain natural vegetation structure in an upland buffer extending out 182 meters (600 feet) from a wetland. In a study of wood ducks in Washington, nests were located from 0 to 350 meters (0 to 1149 feet) from open water; most were within 182 meters (600 feet) of open water (Milligan 1985). Optimum nest cover values are assumed to occur within the first 250 meters from any given wetland (Milligan 1985). In a survey of Swainson's hawks in the Central Valley, Schlorff and Bloom (1984) found that 77% of the nesting territories that they surveyed were within 432 meters (1,500 feet) of riparian and wetland areas and were often found in valley oak (*Quercus lobata*) and Fremont cottonwoods (*Populus fremontii*) that averaged at least 12 meters in height.

An important function of buffer zones is to help insulate sensitive animals from human activity. Josselyn et al. (1989) noted that human activity within 53 meters (175 feet) of different waterbirds could disturb them and cause an evasive response. Buffers composed of high vegetation (2-3 meters) were noted to be moderately to highly effective. Aquatic species are also sensitive to anthropogenic disturbance. Studies of invertebrate interactions within wetland and riparian zones in California suggest that buffers of at least 30 meters are needed to protect the benthic community from impacts associated with timber harvesting (Newbold et al. 1980). Eng (1984) noted that broad habitat protection is more effective that single-species conservation programs for endangered, threatened, and rare invertebrates in California.

Finally, the total width of riparian vegetation retained is an important consideration, because many animal species associated with these communities are area- or edge-sensitive. For example, avian use of riparian and wetland corridors varies with corridor width. On the basis of bird population studies in Maryland and Delaware, Keller et al. (1993) recommended that riparian forests should be at least 100 meters wide to provide some nesting habitat for area-sensitive species.

These studies indicate that conventional, narrow buffer zones for wetlands are usually ineffective, and that wider zones of at least 100 meters are needed to meet minimal wildlife needs. However, even these widths assume that the buffer is in ideal natural habitat. Buffers degraded to some degree, such as by agricultural activity, probably need to be much wider. The extremely wide buffer zones (several miles) recommended for biosphere reserves (e.g., UNESCO 1974) are intended in part to serve as areas for demonstrating land-use practices and lifestyles that are compatible with biodiversity. Such a purpose would also seem appropriate for the lands surrounding the Grasslands Management Area.

<u>Recommendation</u>

Because most of the habitat bordering the Grasslands Management Area is currently in agricultural use, we can expect that this habitat zone will have to be wider than if it were in more natural condition in order to provide the values of buffer zones discussed above. Also, because the values and functions of these zones are diverse, we prefer the term **auxiliary habitat** to buffer zone in this case. Our working hypothesis is that this zone should be at least one mile wide around the Grasslands Management Area to provide these values and functions. Specifically:

1. Any additional development, especially urban, should be prohibited in the one-mile wide (or more) auxiliary habitat zone unless detailed ecological research demonstrates that the development will not compromise the habitat values.

2. As a general rule, any activity that fragments habitat or compromises existing connectivity should be prohibited or rigorously mitigated if the wildlife and ecological values of the Grassland Management Area are to be maintained.

3. In particular, the tenuous habitat linkage between the north and south units should not be further fragmented. Rather, restoration and other activities that enhance the linkage should be undertaken as feasible.

4. The auxiliary habitat zone around the Grasslands Management Area should be used to develop, test, and demonstrate agricultural practices that are compatible with wildlife and biodiversity values. Conservation easements or other agreements that foster agricultural practices conducive to native wildlife should be established. For example, selected fields can be left fallow.

5. Some of the agricultural land--especially in areas where wetland/riparian corridors are presently narrower than optimal--should be restored to wetland condition. Further research is needed to determine the location of priority restoration sites and the types of restoration practices needed.

Detailed studies of species of concern in the Grasslands Management Area are also needed to establish with greater certainty the auxiliary habitat width and levels of connectivity required, and the specific types of land use in these zones that are compatible with native wildlife. Critical information includes data on home range size, movements, and habitat preferences. Species of concern are listed in Table 2.

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Table 1. Determinants of functional connectivity (from Noss and Cooperrider 1994).

1. Mobility or dispersal characteristics of the target species

   a. species-specific habitat preferences for movement

   b. dispersal distance or scale of resource utilization

   c. rate of movement or dispersal (through various types of habitats)

2. Other autecological characteristics of the target species (e.g., preference for particular plant species or structural features of the habitat; feeding and nesting requirements; mortality risks)

3. Landscape context: Structural characteristics and spatial pattern of landscape (patch, corridors, matrix, mosaics)

4. Distance between patches of suitable habitat

5. Presence of barriers to movement (e.g., rivers, roads)

6. Interference from humans, predators, etc.

Table 2. Species of concern in the Grasslands study area.

A joint Federal/State/local government task force has been established to focus on Kern County (San Joaquin Valley), California, endangered species issues. The primary objective of the task force is to develop a plan to conserve listed and candidate species and their habitats. The planning area encompasses the known range of the blunt nosed leopard lizard (*Gambelia silus*), San Joaquin kit fox (*Vulpes macrotis mutica*) and giant kangaroo rat (*Dipodomys ingens*).

[cited in *Endangered Species, Technical Bulletin* vol. XIII(6-7): 3]

Listed species

Blunt-nosed leopard lizard, *Gambelia silus* (E) [habitat mitigation, *Endangered Species, Technical Bulletin*, May, 1987; habitat conservation under Farm bill, *Endangered Species, Technical Bulletin,* May, 1989.]

American peregrine falcon, *Falco peregrinus analus* (E)

San Joaquin kit fox, *Vulpes macrotis mutica* (E) [habitat mitigation, *Endangered Species, Technical Bulletin*, May, 1987.]

Fresno kangaroo rat, *Dipodomys nitratoides exilis* (E) [no references]

Giant kangaroo rat, *D. ingens* (E) [oil exploration concern, *Endangered Species, Technical Bulletin*, Sep. 1987]

Tipton kangaroo rat, *D. nitratoides nitratoides* (E) [approved listing, *Endangered Species, Technical Bulletin*, Aug. 1988]

Valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T) [mitigation of habitat loss, *Endangered Species, Technical Bulletin*, Mar, 1986]

Hoovers wooly-star, *Eriastrum hooveri* (T) [notes on threats to habitat, *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Giant garter snake, *Thamnophis gigas* (E)

Vernal pool fairy shrimp, *Branchinecta lynchi* (E)

Califonia linderiella, *Linderiella occidentalis* (E)

Candidate Species

California tiger salamander, *Ambystoma californiense* [no references]

Western spadefoot toad, *Scaphiopus hammondi hammondi* [no references]

Tricolored blackbird, *Agelaius tricolor* [no references]

White-faced ibis, *Plegadis chihi* [no references]

Mountain plover, *Charadrius montanus* [no references]

California horned lark, *Eremophila alpestris actia* [no references]

Loggerhead shrike, *Lanius ludovicianus* [no references]

Western snowy plover, interior population, *Charadrius alexandrinus nivosus* [no references]

Pacific western big-eared bat, *Plecotus townsendii townsendii* [no references]

Riparian brush rabbit, *Sylvilagus bachmani riparius* [no references]

San Joaquin Valley woodrat, *Veotoma fuscipes riparia* [no references]

San Joaquin dune beetle, *Coelus gracilis* [no references]

Ciervo aegialian scarab beetle, *Aegialia concinna* [no references]

Heartscale, *Atriplex cordulata* [notes on distibution *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Valley spearscale, *A. joaquiniana* [notes on distibution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Fleshy owl's clover, *Castilleja camperstris* [notes on distribution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Hispid bird's beak, *Cordylanthus molls* ssp. *hispidus* [notes on distribution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Delta coyote thistle, *Eryngium racemosum* [notes on distribution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Merced monardella, *Monardella leucocephala* [notes on distribution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Colusa grass, *Neostapfia colusana* [notes on distribution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

San Joaquin orcutt grass, *Orcuttia inaequalis* [notes on distribution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Arburua Ranch jewelflower, *Streptanthus insignis* ssp. *lyonii* [notes on distribution and threats *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*]

Fig. 1. A model reserve network for a human-dominated region, consisting of core reserves, connecting corridors or linkages, and multiple-use buffer zones. Only two core reserves are shown, but a real system may contain many reserves. Outer buffer zones would allow a wider range of compatible human activities than inner buffer zones. In this example, an interregional corridor connects the system to a similar network in another natural region. Adapted from Noss (1992).

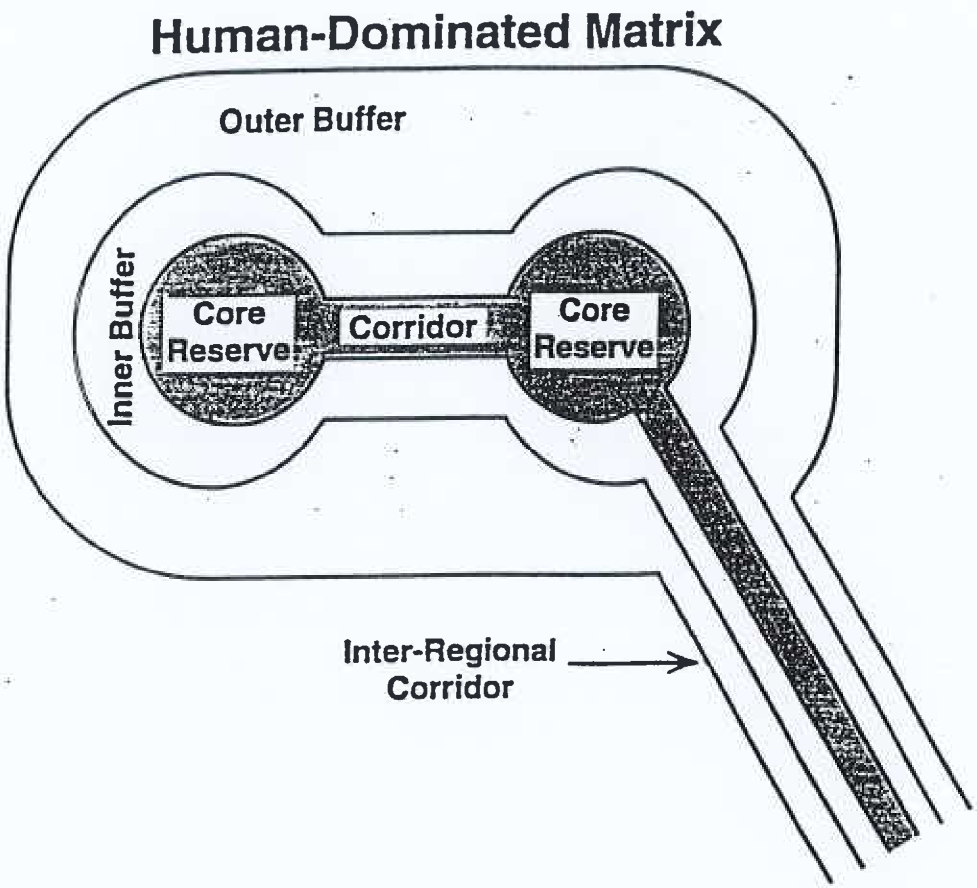

Fig. 1. A model reserve network for a human-dominated region, consisting of core reserves, connecting corridors or linkages, and multiple-use buffer zones. Only two core reserves are shown, but a real system may contain many reserves. Outer buffer zones would allow a wider range of compatible human activities than inner buffer zones. In this example, an interregional corridor connects the system to a similar network in another natural region. Adapted from Noss (1992).

APPENDIX B.

Extensive mapping of geographic information was used to support the recommendations of this study. The digital database, about 325 megabytes of data, includes maps and tabular data all georeferenced and essentially linked to each other. Map based data was translated, and converted as necessary for imput into UNIX based ARC/INFO. Tabular data were input into INFO or left in dos-based spreadsheets with each data item cross referenced to some ARC/INFO attribute (for example MAP INDEX in the Natural Diversity Database and PARCEL # in the Pesticide Permit Application from the Agricultural Commission)

Below is a list of the coverages most used in the study, a listing of the contents of the the computer directories, and the code for each of the AML (ARC Macro Language) scripts used to generate the presentation maps. They are available in the /home/lgwd directory.

All coverages are in the UTM projection, datum NAD27, meters. This allows them to be overlaid on the erdas image file (t4334gras.gis). The source of the data is in parenthesis. Items with an * have detailed code and annotation information in the Data Dictionary folder (ddf).

Coverages preceeded with a # are also to be found as export files *.e00 files in /home/lgwd/arcview. These can be "ftp-ed" (File Transfer Protocol) over to dos for viewing and printing on Arcview.

ANNEX -potential annexations from the 1994 Los Banos General Plan. (TRA)
AINTEREST -expanded sphere of influence identified in 1994 Los Banos General Plan (TRA)
AIMPACT -an area identified for planning purposes in the 1994 Los Banos Beneral Plan, larger than AINTEREST, that includes the area that should be considered when implementing the general plan.
AROADS -all roads within the study area, the .aat has all street names that can be used in arcplot for labeling purposes or in arcedit (item = stname) to id.(MDSS)
BOOK428 * -parcels in Book428 refer to assessor book code, see below (MDSS)
CENSUS90 * -tiger census data for annotation code see data dictionary (TEALE/MDSS)
CORRCLIP - clip coverage to focus on the corridor area (TRA)
COUNTY-the county bnd (MDSS)
FLYLOC -flyover locations for pintail data, karen has joe's write-up about the data (NBB/JOE FLESCKES/TRA)
GENPLAN -outer boundary of general plans for all cities in Merced county(MDSS)
GGP -Gustine general plan with zoning info (MDSS)
GWD -Grassland Water District Boundary (MDSS)
GRIDPOPSP -Projected population coverage- not trnsferred into utm (MDSS)
WDONE -One mile buffer around GWD (TRA)
GWMA -Grassland Wildlife Management Area (MDSS)
GWMAONE- One mile buffer around GWMA (TRA)
GWMASA -Study Area = 2 mile buffer around Grassland Wildlife Manag (MDSS)
LBGP -Los Banos general plan with zoning info (MDSS)
LU90 -1990 Landuse (MDSS/DEPT OF CONSERVATION)
MROAD -main roads in the GWMA study area see aroads(MDSS)

MUNI -municipal boundaries for cities within Merced Co.(MDSS)
NDDB * -Natural Diversity Database point and polygon coverage for all CA rare, threatened and Endangered species. The associated file, nddbdata.df, an upload of the current RareFind database, is accessible only through tables. It is VERY important not to build or clean this coverage! More details are in ddf (CAF&G/NATURAL HERITAGE DIVISION)
NDDBLGWD -NDDB clipped to the corridor area. Unlike the CA wide NDDB this coverage has all the RareFind data directly associated with the arc coverage making it accessible to arcedit, arcplot and arcview. (CAF&G/NATURAL HERITAGE DIVISION/TRA)

The following coverages contain parcel data. Each is numbered with the county assessor book reference code. A map showing the locations of each these book numbers is in the ddf. The assessor's code includes contract (4242) and noncontract (4343) duck clubs, however this information is only available through the INFO datafile PINFO for all but the corridor focus area. The corridor focus area (PARCORR) has all associated code information embedded into it directly.

PARCORR - parcels in the corridor focus area, information from the INFO file PINFO, which can be accessed through TABLES, is already embedded in this coverage further work should include eliminating unneccesary code item in the pat (TRA/MDSS)
PAR20 (MDSS)
PAR25 (MDSS)
PAR26 (MDSS)
PAR40 (MDSS)
PAR45 (MDSS)
PAR49 (MDSS)
PAR54 (MDSS)
PAR55 (MDSS)
PAR56 (MDSS)
PAR59 (MDSS)
PAR63 (MDSS)
PAR64SP - a coverage that refused to be transformed to utm (MDSS)
PAR65 (MDSS)
PAR66 (MDSS)
PAR70 (MDSS)
PAR73 (MDSS)
PAR74 (MDSS)
PAR75 (MDSS)
PAR78 (MDSS)
PAR81 (MDSS)
PAR82 (MDSS)
PAR83 (MDSS)
PAR84 (MDSS)
PAR85 (MDSS)
PAR86 (MDSS)
PAR88 (MDSS)
PAR89 (MDSS)
PAR90 (MDSS)
PARCELSSP - Not transferred to utm, it is an appended file that shows all the arcs in all parcel coverages but has no associated information. (MDSS)

RESE -Reservoirs on the east side of the county(MDSS)
RESW -Reservoirs on the west side of the county(MDSS)
RIVERS - and creeks for the whole county, INFO file include names (item = HLNAME) (MDSS)
SEWERS -shows the sewage ponds for each of the municipalities (MDSS)
SPHERES -sphere of influence for each city (MDSS)
T4334GRAS -an arc/info coverage of the thematic mapper data classified to identify waterfowl habitat. We do not have a good remap table for it yet. The remap table (classlst.rmp) we were sent is not in a readily readable arc/info format. (DU)
T4334GRAS.GIS - an erdas image that shows the 7 waterfowl habitat types in false color and other landuse in straight red/blue/green TM bands. To use it as a base map give the command >image t4334gras.gis (DU)
TOPO15 - outlines of USGS 15' quads for the county (MDSS)
TOPO75 -outline of USGS 7.5' quads for the county(MDSS)
WETLAND - the 1977 National Wetland Inventory data. we have updated 1983 data from DU in /home/lgwd/temp/lisy listed by quad name. They did not send us annotation data, when Barbara comes back from Alaska she will correct this.(MDSS)
WETPOINTS - annotation data for each of the above wetland polygons. (MDSS)

The computer directory listings are also documented in the Data Dictionary.

```
/home/lgwd/tape2
gis1% ls -l
total 152
drwxr-xr-x  2 lgwd   staff    512 Nov  8 03:38 1.map
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:30 annex
drwxr-xr-x  2 lgwd   staff   1024 Nov  7 19:33 aroads
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:30 book428
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:31 census90
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:31 genplan
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:31 ggp
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:32 glanduse
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:32 gridpopsp
drwxr-xr-x  2 lgwd   staff   7680 Nov  8 02:52 info
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:32 lbdiff
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:33 lbgp94
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:33 line
-rw-r--r--  1 lgwd   staff   5993 Nov  8 03:39 log
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:33 lu90
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:32 ludwr
drwxr-xr-x  2 lgwd   staff    512 Nov  8 02:50 ludwrcs
drwxr-xr-x  2 lgwd   staff    512 Nov  8 02:50 ludwrdp
drwxr-xr-x  2 lgwd   staff    512 Nov  8 02:51 ludwrdr
drwxr-xr-x  2 lgwd   staff    512 Nov  8 02:51 ludwri
drwxr-xr-x  2 lgwd   staff    512 Nov  8 02:47 ludwrlb
drwxr-xr-x  2 lgwd   staff    512 Nov  8 02:48 ludwrsl
drwxr-xr-x  2 lgwd   staff    512 Nov  8 02:52 ludwrv
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:33 lulb
drwxr-xr-x  2 lgwd   staff   1024 Nov  7 19:33 mroads2
drwxr-xr-x  2 lgwd   staff    512 Nov  7 19:33 nopclip
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drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par20
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par25
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par26
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par40
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par45
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par49
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par54
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par55
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par56
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:33 par59
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par59sp
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par63
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par64
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par64sp
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par65
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par66
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par70
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par73
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par74
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par75
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par78
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par81
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par82
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par83
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par84
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par85
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par86
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:34 par88
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:35 par89
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:35 par90
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:35 parcorr
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:35 sewers
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:35 topo15
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:35 topo75
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:36 wetland
drwxr-xr-x   2 lgwd     staff        512 Nov  7 19:36 wetpoints
/home/lgwd
gis1% ls -l
total 214
drwxr-xr-x   2 lgwd     staff        512 Oct 11 16:05 ainterest
drwxr-xr-x   2 lgwd     staff       2048 Nov  7 15:36 amls
drwxr-xr-x   2 lgwd     staff        512 Oct 11 16:05 annex
drwxr-xr-x   2 lgwd     staff        512 Oct 14 17:31 close
drwxr-xr-x   2 lgwd     staff        512 Oct 11 16:05 gwmabndstxt
drwxrwxrwx   2 root     other      16384 Nov  8 02:14 info
-rwxrwxrwx   1 13102    20         61277 Nov  7 23:53 log
drwxr-xr-x   2 lgwd     staff        512 Oct 11 16:05 map1
-rw-r--r--   1 lgwd     staff        519 Oct 24 14:00 newcshrc2
-rw-r--r--   1 lgwd     staff        527 Oct 24 14:00 newcshrc2%
drwxr-xr-x   2 lgwd     staff        512 Oct 11 16:05 nop2.ps
```

```
-rw-r--r--   1 lgwd   staff       287 Aug 30 06:03 offmaps
-rw-r--r--   1 lgwd   staff       264 Aug 30 06:03 offmaps%
-rwxrwxrwx   1 lgwd   staff       373 Jul 15 21:37 oldcshrc1
drwxr-xr-x   2 lgwd   staff       512 Oct 11 16:05 page
drwxr-xr-x  46 lgwd   staff      2048 Nov  8 08:21 show
drwxr-xr-x  63 lgwd   staff      1536 Nov  8 03:39 tape2
drwxr-xr-x   3 lgwd   staff       512 Nov  1 17:00 temp
-rw-r--r--   1 lgwd   staff      2998 Jul 20 15:02 toprint
-rw-r--r--   1 lgwd   staff      2963 Jul 20 15:02 toprint%
drwxr-xr-x   2 lgwd   staff      1536 Nov  8 08:30 txt
drwxr-xr-x   3 lgwd   staff       512 Jul 21 15:38 utm
-rw-r--r--   1 lgwd   staff       936 Aug 12 13:15 wetnames
-rw-r--r--   1 lgwd   staff       124 Aug 12 13:15 wetnamex

/home/lgwd/show
gis1% ls -l
total 45074
drwxr-xr-x   2 lgwd   staff       512 Nov  8 03:43 1.map
-rw-r--r--   1 lgwd   staff  11559894 Nov  8 08:21 1.ps
-rw-r--r--   1 lgwd   staff      2073 Nov  1 17:06 1intro.aml
-rw-r--r--   1 lgwd   staff      7649 Nov  8 01:25 1present.aml
-rw-r--r--   1 lgwd   staff      7654 Nov  8 01:25 1present.aml%
-rw-r--r--   1 lgwd   staff      2578 Nov  8 03:16 2image.aml
-rw-r--r--   1 lgwd   staff      2564 Nov  8 03:16 2image.aml%
-rw-r--r--   1 lgwd   staff      2563 Nov  8 03:21 3close.aml
-rw-r--r--   1 lgwd   staff      2418 Nov  8 03:21 3close.aml%
-rw-r--r--   1 lgwd   staff      1657 Nov  8 00:02 4shorebird.aml
-rw-r--r--   1 lgwd   staff      1641 Nov  8 00:02 4shorebird.aml%
-rw-r--r--   1 lgwd   staff      2088 Nov  8 03:27 5mapfly.aml
-rw-r--r--   1 lgwd   staff      2023 Nov  8 03:27 5mapfly.aml%
-rw-r--r--   1 lgwd   staff      1746 Nov  8 00:07 5prnt.aml
-rw-r--r--   1 lgwd   staff      1747 Nov  8 00:07 5prnt.aml%
drwxr-xr-x   2 lgwd   staff       512 Nov  8 01:49 5prnt.map
-rw-r--r--   1 lgwd   staff   2181770 Nov  8 01:53 5prnt.ps
-rw-r--r--   1 lgwd   staff      1534 Nov  8 03:29 6nddb.aml
-rw-r--r--   1 lgwd   staff      1545 Nov  8 03:29 6nddb.aml%
-rw-r--r--   1 lgwd   staff       574 Nov  8 00:30 6prnt.aml
-rw-r--r--   1 lgwd   staff       574 Nov  8 00:30 6prnt.aml%
drwxr-xr-x   2 lgwd   staff       512 Nov  8 01:49 6prnt.map
-rw-r--r--   1 lgwd   staff    207930 Nov  8 01:54 6prnt.ps
-rw-r--r--   1 lgwd   staff      1926 Nov  1 17:08 7lbgp.aml
-rw-r--r--   1 lgwd   staff       393 Nov  8 00:49 7prnt.aml
-rw-r--r--   1 lgwd   staff       424 Nov  8 00:49 7prnt.aml%
drwxr-xr-x   2 lgwd   staff       512 Nov  8 01:49 7prnt.map
-rw-r--r--   1 lgwd   staff   1539716 Nov  8 01:55 7prnt.ps
-rw-r--r--   1 lgwd   staff      1874 Nov  1 17:08 8biosph.aml
-rw-r--r--   1 lgwd   staff      1057 Nov  8 01:10 8prnt.aml
-rw-r--r--   1 lgwd   staff      1037 Nov  8 01:05 8prnt.aml%
drwxr-xr-x   2 lgwd   staff      1024 Nov  8 01:48 8prnt.map
-rw-r--r--   1 lgwd   staff   2154819 Nov  8 01:59 8prnt.ps
```

```
-rw-r--r--   1 lgwd     staff      1052 Nov  8 01:26 8sph.aml
-rw-r--r--   1 lgwd     staff      1039 Nov  8 01:26 8sph.aml%
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 aimpact
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:24 ainterest
drwxr-xr-x   2 lgwd     staff      2048 Nov  8 01:00 amls
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 canals
drwxr-xr-x   2 lgwd     staff       512 Nov  7 23:59 close.map
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 county
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 flyloc
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 gp94lb
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 gwd
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:27 gwdone
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 gwma
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 gwmabnds
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 gwmabndstxt
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:27 gwmaone
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 gwmasa
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 gwmasph
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 hth
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 hyd100k
drwxr-xr-x   2 lgwd     staff       512 Nov  8 02:00 image.map
-rw-r--r--   1 lgwd     staff   1794898 Nov  8 02:00 image.ps
drwxr-xr-x   2 lgwd     staff      4608 Nov  7 19:24 info
drwxr-xr-x   2 lgwd     staff       512 Nov  8 01:48 intro.map
-rw-r--r--   1 lgwd     staff    224877 Nov  8 01:50 intro.ps
drwxr-xr-x   2 lgwd     staff       512 Nov  8 01:49 lbgp.map
-rw-r--r--   1 lgwd     staff    206810 Nov  8 01:52 lbgp.ps
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 lbgp90
-rw-r--r--   1 lgwd     staff    228579 Nov  1 17:01 lgwd-p01.tif
-rw-r--r--   1 lgwd     staff    197570 Nov  1 17:01 lgwd-p02.tif
-rw-r--r--   1 lgwd     staff    212565 Nov  1 17:01 lgwd-p03.tif
-rw-r--r--   1 lgwd     staff    164399 Nov  1 17:01 lgwd-p04.tif
-rw-r--r--   1 lgwd     staff    254796 Nov  1 17:01 lgwd-p05.tif
-rw-r--r--   1 lgwd     staff    177136 Nov  1 17:01 lgwd-p06.tif
-rw-r--r--   1 lgwd     staff    206385 Nov  1 17:01 lgwd-p07.tif
-rw-r--r--   1 lgwd     staff    222594 Nov  1 17:01 lgwd-p08.tif
-rw-r--r--   1 lgwd     staff    233622 Nov  1 17:01 lgwd-p09.tif
-rw-r--r--   1 lgwd     staff    191703 Nov  1 17:01 lgwd-p10.tif
-rw-r--r--   1 lgwd     staff    189434 Nov  1 17:01 lgwd-p11.tif
-rw-r--r--   1 lgwd     staff      3349 Nov  8 08:21 log
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 lu90corr
drwxr-xr-x   2 lgwd     staff       512 Nov  8 01:49 mapfly.map
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 mrnames
drwxr-xr-x   2 lgwd     staff      1024 Nov  7 19:26 mroads
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 muni90lb
drwxr-xr-x   2 lgwd     staff       512 Nov  8 01:49 nddb.map
-rw-r--r--   1 lgwd     staff    364788 Nov  8 01:51 nddb.ps
drwxr-xr-x   2 lgwd     staff       512 Nov  7 19:26 nddbshow
-rw-r--r--   1 lgwd     staff       431 Nov  8 01:48 prnt.aml
-rw-r--r--   1 lgwd     staff       438 Nov  8 01:48 prnt.aml%
```

```
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 public
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 rese
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 resw
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 rivers
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 roadsgp94
-rw-r--r--  1 lgwd  staff  163066 Nov  8 01:50 shbrd.ps
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 shorebird
drwxr-xr-x  2 lgwd  staff     512 Nov  8 01:48 shorebird.map
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 spheres
drwxr-xr-x  2 lgwd  staff     512 Nov  7 19:26 t4334


gis1% pwd
/home/lgwd/txt
gis1% ls -l
total 1118
-rw-r--r--  1 lgwd  staff     735 Nov  8 09:32 1draw.aml
-rw-r--r--  1 lgwd  staff     732 Nov  8 09:32 1draw.aml%
-rwxrwxrwx  1 lgwd  staff     293 Jul 17 12:07 arcprbl.txt
-rw-r--r--  1 lgwd  staff   28530 Aug 15 11:21 chronlgwd.txt
-rw-r--r--  1 lgwd  staff   37666 Aug 15 11:21 chronlgwd.txt%
-rw-r--r--  1 lgwd  staff     585 Aug 12 13:36 chronmap.txt
-rw-r--r--  1 lgwd  staff     348 Sep  2 13:03 conversions.txt
-rw-r--r--  1 lgwd  staff     307 Sep  2 13:03 conversions.txt%
-rw-r--r--  1 lgwd  staff    5480 Nov  8 08:30 covdoc.dos
-rw-r--r--  1 lgwd  staff    5365 Nov  8 03:32 covdoc.txt
-rw-r--r--  1 lgwd  staff    5374 Nov  8 03:32 covdoc.txt%
-rw-r--r--  1 lgwd  staff     396 Jul 26 00:59 covlst.txt
-rw-r--r--  1 lgwd  staff     396 Jul 26 00:58 covlst.txt%
-rw-r--r--  1 lgwd  staff    5743 Jul 22 18:47 doc.txt
-rw-r--r--  1 lgwd  staff    3086 Jul 26 02:06 hanson.txt
-rwxrwxr-x  1 root  other   26030 Jul 15 12:02 hplaser4.txt
-rw-r--r--  1 lgwd  staff   15587 Aug 16 10:36 hydtext
-rw-r--r--  1 lgwd  staff    3169 Jul 26 02:06 lgwd0723.txt%
-rw-r--r--  1 lgwd  staff    2331 Nov  7 18:21 lgwdnddb.aml
-rw-r--r--  1 lgwd  staff     869 Nov  7 18:29 lgwdnddb2.aml
-rw-r--r--  1 lgwd  staff    2331 Nov  7 18:29 lgwdnddb2.aml%
-rw-r--r--  1 lgwd  staff    3016 Aug 18 19:54 memo0816.txt
-rw-r--r--  1 lgwd  staff    2436 Aug 18 19:54 memo0816.txt%
-rw-r--r--  1 lgwd  staff   16548 Jun 10 11:41 nddb.txt
-rw-r--r--  1 lgwd  staff   10750 Aug 29 12:56 nddbAAT
-rw-r--r--  1 lgwd  staff    2151 Aug 29 13:04 nddbcheck
-rw-r--r--  1 lgwd  staff    3797 Aug 29 13:01 nddbfix
-rw-r--r--  1 lgwd  staff    3827 Aug 29 13:01 nddbfix%
-rw-r--r--  1 lgwd  staff    1929 Aug 29 12:24 nddbfix2
-rw-r--r--  1 lgwd  staff    3827 Aug 29 12:24 nddbfix2%
-rw-r--r--  1 lgwd  staff    2487 Aug 29 12:48 nddbfix3
-rw-r--r--  1 lgwd  staff    2521 Aug 29 12:47 nddbfix3%
-rw-r--r--  1 lgwd  staff   15821 Aug 29 13:03 nddbpat
-rwxrwxrwx  1 lgwd  staff    1103 Jul 17 12:07 problems
```

```
-rwxrwxrwx   1 lgwd    staff      1102 Jul 17 12:07 problems%
-rw-r--r--   1 lgwd    staff       453 Aug 29 10:44 publicpat.aml
-rw-r--r--   1 lgwd    staff      5253 Aug 29 13:52 templgwd.txt
-rw-r--r--   1 lgwd    staff      5252 Aug 29 13:52 templgwd.txt%
-rw-r--r--   1 lgwd    staff      2074 Nov  8 02:40 topmr.txt
-rw-r--r--   1 lgwd    staff     10941 Oct 25 12:13 topnntdir
-rw-r--r--   1 lgwd    staff      8553 Oct 25 12:13 topnntdir%
-rw-r--r--   1 lgwd    staff    140847 Oct 25 11:34 topnntfilelist
-rw-r--r--   1 lgwd    staff     99415 Oct 25 11:34 topnntfilelist%
-rw-r--r--   1 lgwd    staff      1179 Aug 26 16:15 toprint
-rw-r--r--   1 lgwd    staff      2500 Aug 16 11:22 toprintlgwd.txt
-rw-r--r--   1 lgwd    staff      4224 Nov  3 09:19 tosend.txt
-rw-r--r--   1 lgwd    staff      4196 Nov  3 09:19 tosend.txt%
-rw-r--r--   1 lgwd    staff     12676 Aug 16 10:35 wmatext


gis1% pwd
/home/lgwd/temp/lisy  (Wetland coverages provided by DU)
gis1% ls -l
total 62
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 arena
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 arena-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 atwate
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 atwate-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:27 charle
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:27 charle-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 deltar
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 deltar-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 dospal
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 dospal-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 elnido
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 elnido-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 gustin
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 gustin-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 ingoma
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 ingoma-a
-rw-r--r--   1 lgwd    staff        81 Nov  8 02:10 log
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 losban
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 losban-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 newman
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 newman-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 sandym
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 sandym-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 sanluir
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 sanluir-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 stevin
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 stevin-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 turner
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 turner-a
drwxr-xr-x   2 lgwd    staff       512 Sep 28 13:28 volta
```

```
drwxr-xr-x   2 lgwd     staff        512 Sep 28 13:28 volta-a


/home/lgwd/amls
gis1% ls -l
total 332
-rw-r--r--   1 lgwd     staff       2097 Nov  7 21:46 1intro.aml
-rw-r--r--   1 lgwd     staff       2095 Nov  7 21:46 1intro.aml%
-rw-r--r--   1 lgwd     staff       7241 Nov  7 21:30 1present.aml
-rw-r--r--   1 lgwd     staff       7240 Nov  7 21:30 1present.aml%
-rw-r--r--   1 lgwd     staff       2325 Nov  1 13:16 2image.aml
-rw-r--r--   1 lgwd     staff       2321 Nov  1 13:16 2image.aml%
-rw-r--r--   1 lgwd     staff       3352 Oct  3 11:12 2present.aml
-rw-r--r--   1 lgwd     staff       3352 Oct  3 11:12 2present.aml%
-rw-r--r--   1 lgwd     staff        276 Aug 19 18:31 2t1precision2.aml
-rw-r--r--   1 lgwd     staff        842 Aug 19 18:31 2t1precision2.aml%
-rw-r--r--   1 lgwd     staff       1352 Aug 19 16:30 2to1precision
-rw-r--r--   1 lgwd     staff        842 Aug 19 16:30 2to1precision%
-rw-r--r--   1 lgwd     staff        842 Aug 19 16:23 2to1precision.aml
-rw-r--r--   1 lgwd     staff       2418 Oct  4 11:34 3close.aml
-rw-r--r--   1 lgwd     staff       2809 Oct  4 11:34 3close.aml%
-rw-r--r--   1 lgwd     staff       1641 Oct 13 17:42 4shorebird.aml
-rw-r--r--   1 lgwd     staff       1614 Oct 13 17:42 4shorebird.aml%
-rw-r--r--   1 lgwd     staff       1776 Oct  4 13:03 5mapfly.aml
-rw-r--r--   1 lgwd     staff       1776 Oct  4 13:03 5mapfly.aml%
-rw-r--r--   1 lgwd     staff       1545 Oct  4 14:10 6nddb.aml
-rw-r--r--   1 lgwd     staff       1629 Oct  4 14:10 6nddb.aml%
-rw-r--r--   1 lgwd     staff       1926 Nov  1 13:10 7lbgp.aml
-rw-r--r--   1 lgwd     staff        765 Nov  1 13:10 7lbgp.aml%
-rw-r--r--   1 lgwd     staff       1874 Nov  1 14:41 8biosph.aml
-rw-r--r--   1 lgwd     staff       1874 Nov  1 14:41 8biosph.aml%
-rw-r--r--   1 lgwd     staff       1963 Nov  7 15:39 8biospha.aml
-rw-r--r--   1 lgwd     staff       1926 Nov  7 15:39 8biospha.aml%
-rw-r--r--   1 lgwd     staff       1881 Nov  1 14:14 8sphere.aml
-rw-r--r--   1 lgwd     staff       1153 Nov  1 14:14 8sphere.aml%
-rwxrwxrwx   1 13108    staff         66 Jun 15 09:50 apnrel.aml
-rw-r--r--   1 lgwd     staff        405 Jul 25 22:18 build1.aml
-rw-r--r--   1 lgwd     staff       1041 Oct 13 17:47 clear.aml
-rw-r--r--   1 lgwd     staff        165 Oct 13 17:47 clear.aml%
-rw-r--r--   1 lgwd     staff       1187 Nov  1 17:10 clearif.aml
-rw-r--r--   1 lgwd     staff       1165 Nov  1 17:10 clearif.aml%
-rwxrwxrwx   1 lgwd     staff       1091 Jul 18 14:44 copy.aml
-rwxr-xr-x   1 lgwd     staff       1096 Jul 18 14:44 copy.aml%
-rw-r--r--   1 lgwd     staff       1085 Nov  1 16:40 copy2tape1.aml
-rw-r--r--   1 lgwd     staff       2562 Nov  1 18:30 copy2tape2.aml
-rw-r--r--   1 lgwd     staff       2674 Nov  1 18:30 copy2tape2.aml%
-rw-r--r--   1 lgwd     staff       1697 Nov  1 16:38 copytape1.aml
-rw-r--r--   1 lgwd     staff       1704 Nov  1 16:38 copytape1.aml%
-rw-r--r--   1 lgwd     staff       2817 Nov  1 17:41 copytape2.aml
-rw-r--r--   1 lgwd     staff       2817 Nov  1 17:41 copytape2.aml%
```

```
-rw-r--r--   1 lgwd    staff    1316 Aug 19 19:02 export.aml
-rw-r--r--   1 lgwd    staff    1314 Aug 19 19:02 export.aml%
-rw-r--r--   1 lgwd    staff    1341 Jul 26 00:58 export1.aml
-rw-r--r--   1 lgwd    staff     271 Aug 19 19:21 export2.aml
-rw-r--r--   1 lgwd    staff     350 Aug 19 19:21 export2.aml%
-rwxrwxrwx   1 13102   20       1911 May 19 09:10 flyloc.aml
-rwxrwxrwx   1 13102   20       1760 May 19 09:10 flyloc.aml%
-rw-r--r--   1 lgwd    staff     648 Sep 28 11:09 heading.aml
-rw-r--r--   1 lgwd    staff     756 Sep 28 11:09 heading.aml%
-rw-r--r--   1 root    other     361 Sep 27 18:14 intro.aml
-rw-r--r--   1 lgwd    staff     361 Sep 28 11:07 intro.aml%
-rw-r--r--   1 lgwd    staff    3441 Sep 30 16:44 intro1.aml%
-rw-r--r--   1 lgwd    staff     527 Oct 11 13:28 kill1011
-rw-r--r--   1 lgwd    staff     527 Oct 11 13:28 kill1011.aml
-rw-r--r--   1 lgwd    staff    1397 Sep 28 11:18 lgwdprsnt.aml
-rw-r--r--   1 lgwd    staff    1130 Sep 28 11:18 lgwdprsnt.aml%
-rw-r--r--   1 lgwd    staff     816 Aug 15 12:33 lutxt.aml
-rw-r--r--   1 lgwd    staff     847 Aug 15 12:33 lutxt.aml%
-rw-r--r--   1 lgwd    staff     534 Aug 12 15:33 nddbsym.aml
-rw-r--r--   1 lgwd    staff     843 Aug 12 15:33 nddbsym.aml%
-rw-r--r--   1 lgwd    staff     295 Aug 15 20:46 parcorrlu.aml
-rw-r--r--   1 lgwd    staff     286 Aug 15 20:46 parcorrlu.aml%
-rw-r--r--   1 lgwd    staff    3310 Sep 30 18:01 present.aml
-rw-r--r--   1 lgwd    staff    3306 Sep 30 18:01 present.aml%
-rw-r--r--   1 lgwd    staff     261 Aug 19 18:57 rename.aml
-rw-r--r--   1 lgwd    staff     363 Aug 19 18:57 rename.aml%
-rw-r--r--   1 lgwd    staff     948 Jul 24 14:32 rename1.aml
-rw-r--r--   1 lgwd    staff    1104 Jul 24 14:32 rename1.aml%
-rw-r--r--   1 lgwd    staff      22 Aug 28 12:36 rmvmaps.aml
-rw-r--r--   1 lgwd    staff      45 Aug 28 12:36 rmvmaps.aml%
-rw-r--r--   1 lgwd    staff     128 Nov  1 12:00 sp_utm.prj
-rw-r--r--   1 lgwd    staff     106 Nov  1 12:00 sp_utm.prj%
-rw-r--r--   1 lgwd    staff    1273 Aug 19 18:58 u2dscr
-rw-r--r--   1 lgwd    staff    1273 Aug 19 18:58 u2dscr%
-rw-r--r--   1 lgwd    staff    2620 Jul 23 16:59 utm.aml
-rw-r--r--   1 lgwd    staff    2677 Jul 23 16:59 utm.aml%
-rw-r--r--   1 lgwd    staff     663 Jul 23 18:05 utm2.aml
```

```
/home/lgwd/tape2/ludwr
gis1% ls -l
total 11716
-rw-r--r--   1 lgwd    staff   126304 Jul 22 14:25 lu3828.e00
-rw-r--r--   1 lgwd    staff   303813 Jul 22 14:26 lu3829.e00
-rw-r--r--   1 lgwd    staff   242076 Jul 22 14:26 lu3830.e00
-rw-r--r--   1 lgwd    staff   427243 Jul 22 14:26 lu3831.e00
-rw-r--r--   1 lgwd    staff   906203 Jul 22 14:27 lu3832.e00
-rw-r--r--   1 lgwd    staff   192711 Jul 22 14:28 lu3929.e00
-rw-r--r--   1 lgwd    staff   150142 Jul 22 14:28 lu3930.e00
-rw-r--r--   1 lgwd    staff   308194 Jul 22 14:28 lu3932.e00
```

```
-rw-r--r--  1 lgwd  staff  679852 Jul 22 14:29 lu3933.e00
-rw-r--r--  1 lgwd  staff  538810 Jul 22 14:29 lu4029.e00
-rw-r--r--  1 lgwd  staff  557514 Jul 22 14:29 lu4030.e00
-rw-r--r--  1 lgwd  staff  729274 Jul 22 14:30 lu4031.e00
-rw-r--r--  1 lgwd  staff  287119 Jul 22 14:31 lu4130.e00
-rw-r--r--  1 lgwd  staff  363610 Jul 22 14:31 lu4131.e00
-rw-r--r--  1 lgwd  staff    1938 Jul 22 14:32 reidlanduse.list
```

The USFWS map showing detailed info (regarding irrigation, shcedules, locations of ditches, etc) for all conservation easement properties remains in its DOS-AutoCAD format.

AML (ARC Macro Language) Scripts to generate maps for presentation.

```
/* ____________________________________________________________
/*
/*   Program: 1intro.aml
/*   Purpose: Create intro1.map a duplicate of the first map,
/*            intro.aml, created by the present.aml script.
/*            It shows the geographical relationships between the
/*            gwma and the cities surrounding it.
/* ____________________________________________________________
/*
/*   Inputs:
/*   Outputs:  screen output
/*             graphics file
/*
/* ____________________________________________________________
/*
/*   History: 8/94 original coding, recoded 9/94 after erasure and
/*            backup recovery failure.
/*
/*
/*
/* ____________________________________________________________
/*
&echo &on
&r offmaps
/*intro.map
/*image.map
/*shorebird.map
/*pblnds.map
/*nddb.map
/*lbgp.map
/*lglu.map
/*flymap.map
/*sph.map
imageview create tifvert size canvas 540 900 position 600 0
imageview create tifhori size canvas 1200 768 position ul
&pause
/*  intro.map begins the presentation by locating the geographical
/*  relationships between the gwma and the cities surrounding it.
map 1intro.map
mape gwmasa
lineset carto.lin
linesym 103
linecolor 3
arcs gwma
LINE 8.8 1.8 9.1 2.3 9.4 1.8  9.7 2.3
TEXTSIZE .3 .3
TEXTSET FONT.TXT
```

```
TEXTSYM 9
MOVE 9.9 2.1
TEXT 'GRASSLAND WILDLIFE'
MOVE 9.9 1.8
TEXT 'MANAGEMENT AREA'
linesym 201
arcs mroads
linesym 102
linecolor 7
arcs muni
textset font.txt
textsym 3
textsize .194 .194
move 5.6 3.4
text 'HWY 152'
textsize .15 .15
move 3.6 4.2
text 'HENRY MILLER ROAD'
textsize .15 .15
move 2.6 8.5
text 'HWY 140'
textsym 21
textsize .3 .3
move 6.95 1.65
text 'Dos Palos'
move 10 8.5
text 'Merced'
move 2.5 2.9
text 'Los Banos'
move 1.7 7.2
text 'Gustine'
lineset carto.lin
linesym 103
/*units map
/*line 727182 4090503 744884.94 4090503
/*text '5 MILES'
map end
```

```
/* ____________________________________________________________
/*
/*    Program:  2image.aml
/*    Purpose:  Display a color enhanced satellite view showing a
/*              regional view of the landscape.  Discuss two of the
/*              most important principles of conservation biology:
/*              AVOID FRAGMENTING HABITAT AND KEEP LINKS BETWEEN
/*              HABITAT PATCHES.
/*              Points to be made within the context of Conservation
/*              Biology are A) two major blocks of wetland habitat
/*              exist, one to the north and another to the south.
/*              These areas are identified by the enhanced colors
/*              blue = open water magenta = growing emergent vegetation,
/*              green = turbid water yellow = rice fields.   B) There
/*              is a natural corridor between the two areas, to the
/*              east of Los Banos, that provides a landscape linkage
/*              between them. c) This linkage is extremely important,
/*              it connects two areas of high biotic resource, greatly
/*              enhancing both of the biotic potential of each area.
/* ____________________________________________________________
/*
/*    Inputs:
/*    Outputs:  screen output
/*              graphics file
/*
/* ____________________________________________________________
/*
/*    History: 8/94 original coding, recoded 9/94 after erasure and
/*             backup recovery failure.
/*
/*
/*
/* ____________________________________________________________
/*
mape gwmasa
image /home/lgwd/temp/t4334/t4334gras.gis
mape gwmasa
lineset carto.lin
linesym 103
linecolor 3
arcs gwma
units page
linesym 201
arcs mroads
linesym 102
linecolor 7
arcs muni94lb
textset font.txt
textsym 3
```

```
textsize .194 .194
units page
move 5.6 3.4
text 'HWY 152'
textsize .15 .15
move 3.6 4.2
text 'HENRY MILLER ROAD'
textsize .15 .15
move 2.6 8.5
text 'HWY 140'
textsize .4 .4
textsym 21
move 6.95 1.75
text 'Dos Palos'
move 10 8.5
text 'Merced'
move 2.5 2.9
text 'Los Banos'
move  0.677 6.95
text 'Gustine'
units map
linesym 104
box 720521.55 4088840.828 728568.285 4088840.828
move  721571.787  4086970.478
text '5 MILES'
msel 2 3 4 5 6 7 8 9 10 11 12 13
mdel
linecolor 5
arcs gwd
```

```
/* ______________________________________________________________
/*
/*   Program:  3close.aml
/*   Purpose:  To bring familiar photographic views of the landscape
/*             into close association with the satellite view by
/*             displaying a closeup of the a color enhanced
/*             satellite view (2image.map) and while toggling
/*             between the satellite view of the area and the
/*             relatively familiar photo views of the area.
/* ______________________________________________________________
/*
/*   Notes:    Discussion with photos can include:
/*             a) lgwd-p01.tif - the old Pajaro Vista site with the
/*             fish ponds in the lower left next to HWY 152 and the
/*             reservoir below the sewage ponds(not visible) on edge
/*             of Santa Fe Grade.
/*             b) lgwd-p02.tif - the sewage ponds in the background
/*             and the latest development in the foreground.  To
/*             the east is more agriculture and wetland area.
/*             c) lgwd-p06.tif - Klamath duck club, northeast
/*             of the sewage ponds (in background), is optimum
/*             waterfowl habitat.
/*             d) lgwd-p10.tif - Open water habitat with emergent
/*             marsh.
/*             e) lgwd-p11.tif - Vast stretches of emergent fresh
/*             water marsh. Segue into multispecies management
/*             requirements (GGS)
/*
/* ______________________________________________________________
/*
/*   Inputs:
/*   Outputs:  screen output
/*             graphics file
/*
/* ______________________________________________________________
/*
/*   History: 8/94 original coding, recoded 9/94 after erasure and
/*            backup recovery failure.
/*
/*
/*
/* ______________________________________________________________
/*
map close.map
imageview create tifvert size canvas 540 900 position 600 0
imageview create tifhori size canvas 1200 750 position ul
mape 688806.026 4108999.047 699751.038 4100824.923
image /home/lgwd/temp/t4334/t4334gras.gis
arcs mroads
```

```
textsize .194 .194
move 5.6 3.4
text 'HWY 152'
textsize .15 .15
move 3.6 4.2
text 'HENRY MILLER ROAD'
textsize .15 .15
imageview lgwd-p01.tif # # tifhori
&tty
imageview lgwd-p02.tif # # tifvert
&tty
imageview lgwd-p06.tif # # tifhori
&tty
imageview lgwd-p10.tif # # tifhori
&tty
imageview lgwd-p11.tif # # tifhori
map end
&tty
```

```
/*
/*  ______________________________________________________________
/*
/*      Program:  4shorebird.aml
/*      Purpose:  Show relative shorebird diversity of the grassland
/*                area.
/*  ______________________________________________________________
/*
/*      Notes:    Two focal areas of high diversity are centered
/*                within each of the two wetland areas.
/*                To the east of Los Banos is a contiguious stretch
/*                of medium diversity linking the two high diversity
/*                patches.  To the west are lower diversity areas.
/*______________________________________________________________
/*      Inputs:
/*      Outputs:  screen output
/*                graphics file
/*  ______________________________________________________________
/*
/*      History: 8/94 original coding, recoded 9/94 after erasure and
/*               backup recovery failure.
/*______________________________________________________________
/*&if [exists /home/lgwd/shorebird.map -directory] &then
/*    &do
/*      &sys rm -r /home/lgwd/shorebird.map
/*    &end
/*&else
/*&do
/*&pause
/*&end
/*&pause
mape gwmasa
units page
map shorebird.map
SHADESET CARTO.SHD
polygonsh shorebird div shorebird.lut
textset font.txt
textsym 3
TEXTSIZE .5 .5
MOVE 7.96 7.55
TEXT 'SHOREBIRD DIVERSITY'
textsize .3 .3
KEYAREA 9.93 6.6 12.6 3.84
keyshade shorebird.lut info symbol text nobox
textsize .25 .25
move 9.36 2.55
text 'Raw data provided by'
move 9.36 2.08
text 'Point Reyes Bird Observatory'
map end
```

```
/* ________________________________________________________________
/*     Program:  5mapfly.aml
/*     Purpose:  Show area of pintail movement using Joe Fleskes
/*               pintail flight location data
/*
/* ________________________________________________________________
/*
/*     Notes:    Two focal areas of high diversity are centered
/*               within each of the two wetland areas.
/*               To the east of Los Banos is a contiguious stretch
/*               of medium diversity linking the two high diversity
/*               patches.  To the west are lower diversity areas.
/*
/* ________________________________________________________________
/*
/*     Inputs:
/*     Outputs:  screen output
/*               graphics file
/*
/* ________________________________________________________________
/*
/*     History: 8/94 original coding, recoded 9/94 after erasure and
/*              backup recovery failure.
/* ________________________________________________________________
mape gwma
map 5prnt.map
linecolor 6
arcs gwma
textsize .26 .26
lineset carto.lin
linesym 103
linecolor 7
arcs flyloc
line 10.2 6.1 10.35 6.7 10.5 6.1 10.65 6.7
move 10.8 6.24
text 'Pintail flight movements'
move 10.8 5.9
text 'on 3 hunt days, 1992'
linesym 108
linecolor 5
arcs gwd
line 10.2 3.6 10.35 4.2 10.5 3.6 10.65 4.2
move 10.88 3.75
text 'GRASSLAND WATER'
move 11.42 3.43
text 'DISTRICT'
textsize .215 .215
move 10.88 5.5
text 'personal communication'
move 10.88 5.3
```

```
text 'Joe Fleskes'
move 10.88 5.1
text 'National Biological Survey'
move 10.88 4.9
text 'Dixon, CA'
arcs public
labeltext public text
map end
```

```
/* ________________________________________________
/*
/*   Program:  6nddb.aml
/*   Purpose:  To show the endangered, threatened and rare species
/*             that are listed in the Natural Diversity
/*             Database.
/*
/* ________________________________________________
/*   Notes:    after the map is drawn, the identify command will
/*             allow the user to query 4 keymarker points.  If you
/*             pick the point in Los Banos be aware that
/*             there are numerous old (1931) records at that point.
/*             The  first record that will show is a yellow rail.
/* ________________________________________________
/*
/*   Inputs:
/*   Outputs:  screen output
/*             graphics file
/*
/* ________________________________________________
/*
/*   History: coded 9/94
/* ________________________________________________
&sys rm -r nddb.map
map nddb.map
linesym 101
linecolor 5
arcs canals
arcs hyd100k
linecolor 2
arcs mroads
linecolor 7
arcs muni
markerset municipal.mrk
pointmarker nddbshow cname nddbshow.lut
box 10.113 9.387 13.816 0.62
textsize .17 .17
textoffset 0 -.1
keyarea 10.113 9.387 13.816 0.62
keymarker nddbshow.lut info symbol cname nobox
textsize .22 .22
MOVE 10.175 0.320
text 'NATURAL DIVERSITY DATABASE 1994'
map end
identify nddbshow point *
identify nddbshow point *
identify nddbshow point *
identify nddbshow point *
```

```
/* ____________________________________________________________
/*
/*    Program:  7lbgp.aml
/*    Purpose:  To show the planned expansion of Los Banos in light
/*              of the previous information shown in the presentation
/*              script (1present.aml).
/*              The landuse plan of 8/94 is incompatible with the
/*              landuse requirements of the biological resources
/*              of Los Banos.  An area of resource benefical use
/*              and resource neutral use is identified for discussion
/*              purposes (hence not included in the legend).
/* ____________________________________________________________
/*
/*    notes:
/*map
/*
/* ____________________________________________________________
/*
/*    Program:  8biosph.aml
/*    Purpose:  To show the spheres of influence for the cities
/*              close to GWMA, and the one and two-mile spheres
/*              of the GWMA.
/*
/* ____________________________________________________________
/*
/*    Inputs:
/*    Outputs:  screen output
/*              graphics file
/*
/* ____________________________________________________________
/*
/*    History: 8/94 original coding, recoded 9/94 after erasure and
/*             backup recovery failure.
/*______________________________________________________________
/*
map biosph.map
mape gwmasa
image /home/lgwd/temp/t4334/t4334gras.gis
shadeset color.shd
shadesym 1
units page
patch 10.09 9.5 13.92 0.04
textset font.txt
textsym 3
textcolor 0
textsize .4 .4
move 10.75 9.01
text "SPHERES OF"
```

```
MOVE 11 8.56
TEXT "INFLUENCE"
lineset carto.lin
textsym 3
textsize .3 .3
textcolor 0
linesym 202
arcs mroads
linesym 102
linecolor 0
arcs spheres
line 10.6 7 10.75 7.6 10.9 7.0 11.05 7.6
move 11.3 7.3
text "City Spheres"
linesym 103
linecolor 3
arcs gwma
line 10.6 6 10.75 6.6 10.9 6.0 11.05 6.6
move 11.3 6.4
text "Grassland Wildlife"
move 11.3 6.1
text "Management Area"
linecolor 5
arcs gwd
line 10.6 5 10.75 5.6 10.9 5.0 11.05 5.6
move 11.3 5.4
text "Grassland Water"
move 11.6 5.1
text "District"
move 11.3 4.4
text "GWMA 1 mile"
move 11.6 4.1
text "sphere"
linecolor 7
arcs gwmaone
arcs gwmasa
line 10.6 4 10.75 4.6 10.9 4.0 11.05 4.6
line 10.6 3 10.75 3.6 10.9 3.0 11.05 3.6
lineset oilgas.lin
linesym 102
linecolor 9
arcs gwmasa
line 10.6 3 10.75 3.6 10.9 3.0 11.05 3.6
move 11.3 3.4
text "GWMA 2 mile"
move 11.6 3.1
text "sphere"
map end
```

APPENDIX C. Data Transfer/ GWD Computer Implementation.

Three basic options exist for the transfer and use of the database developed by Thomas Reid Associates.

1. Use existing resources for map viewing and provide data tapes to researchers with ARC/INFO or other GIS system for working with files. This option will allow you to view and print the maps as a graphic file or import them into a graphic program (Aldus FREEHAND, MACPAINT) for further non-geographically referenced manipulation.

Cost: minimal (floppy discs and 2-3 1/4" tape drives @ $15/tape.)

2. Acquire pc ARCVIEW software from ESRI and a cd-rom and cd-rom drive. This option allows you to view and update the datafiles.

Cost: $150 CD ROM disc (additional CD ROM's @ $15 - 55/disc depending on quantity.
$200-400 CD ROM disc drive
$995 ARCVIEW for pc

3. Acquire pc ARC/INFO. This option allows you full manipulation of the data.

Cost: $3500