Heidi — here's the invertebrate stuff as promised.
You can reference this report — it was finalized.
Brenda

PHASE I REPORT - SENSITIVE SPECIES

INTERIM SOUTH DELTA PROJECT

419

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Invertebrates

The following accounts of the 21 invertebrate species contained in the USFWS lists represent a compilation of information from many sources, both published and unpublished. Detailed information on invertebrate species, especially for federal candidates, is lacking in the majority of governmental and private consultant reports mainly because so little is known about many of these species. The species accounts presented in this chapter attempt to pull all available information together to yield a comprehensive narrative on each individual species of concern.

The distribution maps for invertebrates differ from the preceding wildlife species in that the majority of maps indicate documented occurrences, rather than range. This provides a more accurate picture of a species' distribution since many of the invertebrates discussed in this section are known from only a few localities.

Lange's Metalmark Butterfly

Status

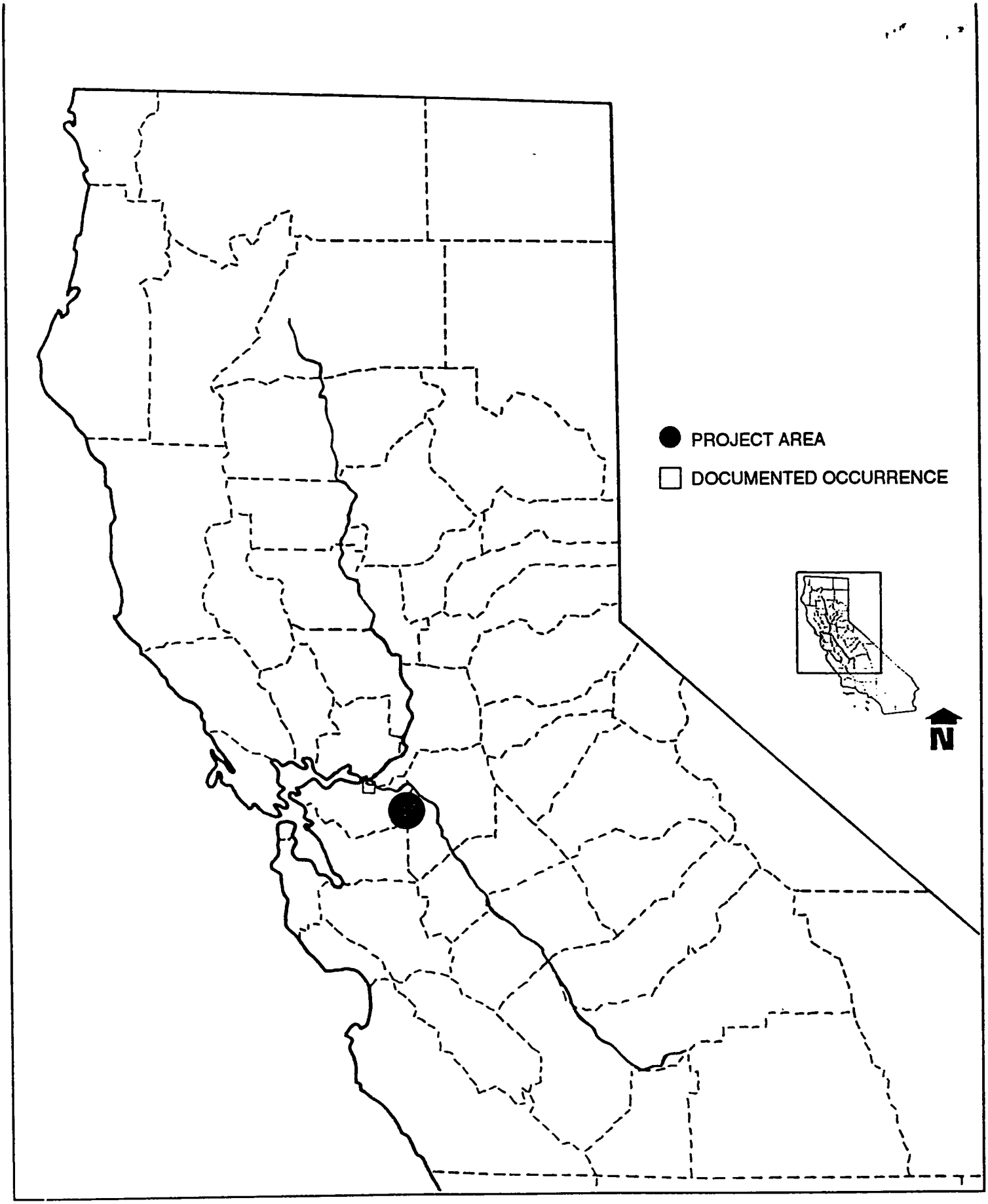
Lange's metalmark butterfly (*Apodemia mormo langei*) was listed by the USFWS as endangered on July 1, 1976 (Edwards 1985). It has no state status.

Distribution

This species is known only from Contra Costa County, where it inhabits the relict Antioch Dunes, on the south bank of the San Joaquin River, near its confluence with the Sacramento River (NDDB 1992). Historically, its range may have included the entire extent of a now-destroyed 500-acre dune system. It is believed this system was part of a prehistoric desert which extended into California's Central Valley (USFWS 1980). While historical data (1937) indicate a collection slightly southeast at Oakley (Opler and Powell 1962 *in* Arnold 1983), its current range comprises only about 15 acres of the remaining dunes (WWF 1990, Powell 1981, Arnold 1983). Specific locational information has been suppressed to discourage unpermitted collection.

Habitat Requirements

Lange's metalmark butterfly inhabits stabilized sand dunes, and all developmental stages are closely associated with its larval host plant, naked buckwheat (*Eriogonum nudum* var. *auriculatum*). While adults may perch and feed upon various wildflowers, and may utilize lupine (*Lupinus albifrons*) as a mating substrate (USFWS 1992), eggs are deposited only on



Distribution of the Lange's Metalmark Butterfly in California

the larval food plant (Arnold 1983). In addition, population demography is believed to be related to buckwheat demography (USFWS 1992).

Critical Habitat

While no critical habitat has been designated specifically for Lange's metalmark, the majority of its current range is within critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). In 1980, approximately 55 acres of the Antioch Dune system were acquired by the USFWS (USFWS 1980), and were subsequently placed in the San Francisco Bay National Wildlife Refuge Complex (WWF 1990). These lands, along with additional acquisitions, now comprise the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990). The majority of established Lange's metalmark range lies within the reserve.

Reasons for Decline

Data from 1986-88 have been extrapolated to yield a current population estimate of 400 individuals (WWF 1990). Despite recovery efforts including habitat protection, captive breeding, and transfer of individuals within the reserve, the population has been reported as "declining for unknown reasons" (USFWS 1992).

The single greatest threat to the species is habitat destruction. Historically, the once-large dune system has been destroyed by land reclamation for agricultural development, and by economic development activities (e.g., sand mining). The geographic restriction of the species to such a small range renders it exceptionally vulnerable to localized episodic upset, such as the fires reported in 1977 and 1978 (Arnold 1983). The most acute remaining threat appears to be habitat destruction resulting from pedestrian and off-road vehicular traffic which disturbs the fragile dune ecosystem. This threat has been greatly reduced since the habitat has been protected.

Potential for Occurrence in the PSA

Due to the lack of suitable relict dune habitat, the potential for occurrence of Lange's metalmark butterfly in the ISDP area is considered unlikely. In general, the level of disturbance in the Delta may preclude the possibility of suitable habitat remaining. Despite extensive work in the area, this habitat type has not been reported and preliminary reconnaissance surveys have identified none. Results of DWR's Delta modeling studies indicate that the various alternatives being considered for the ISDP would not measurably change water levels outside of the PSA; therefore, no impacts to Lange's matalmark butterfly or its habitat are anticipated.

Proposed Survey Methodology

No field surveys are proposed for this species; however, the presence of relict dune habitat, especially that supporting *Eriogonum nudum* var. *auriculatum*), will be noted during survey work for other species. It is important to note that such habitat should constitute "true" relict dune, and not recently formed and/or disturbed, sandy habitat. None is expected to be found.

Should the larval host plant be identified in "significant" quantity and distribution, field surveys during the peak adult mating/flight season (August to mid-September) would be conducted. If implemented, these surveys would consist of approximately one field day per week during the six-week period. Field surveys should be conducted during daylight hours on relatively calm days.

Valley Elderberry Longhorn Beetle

Status

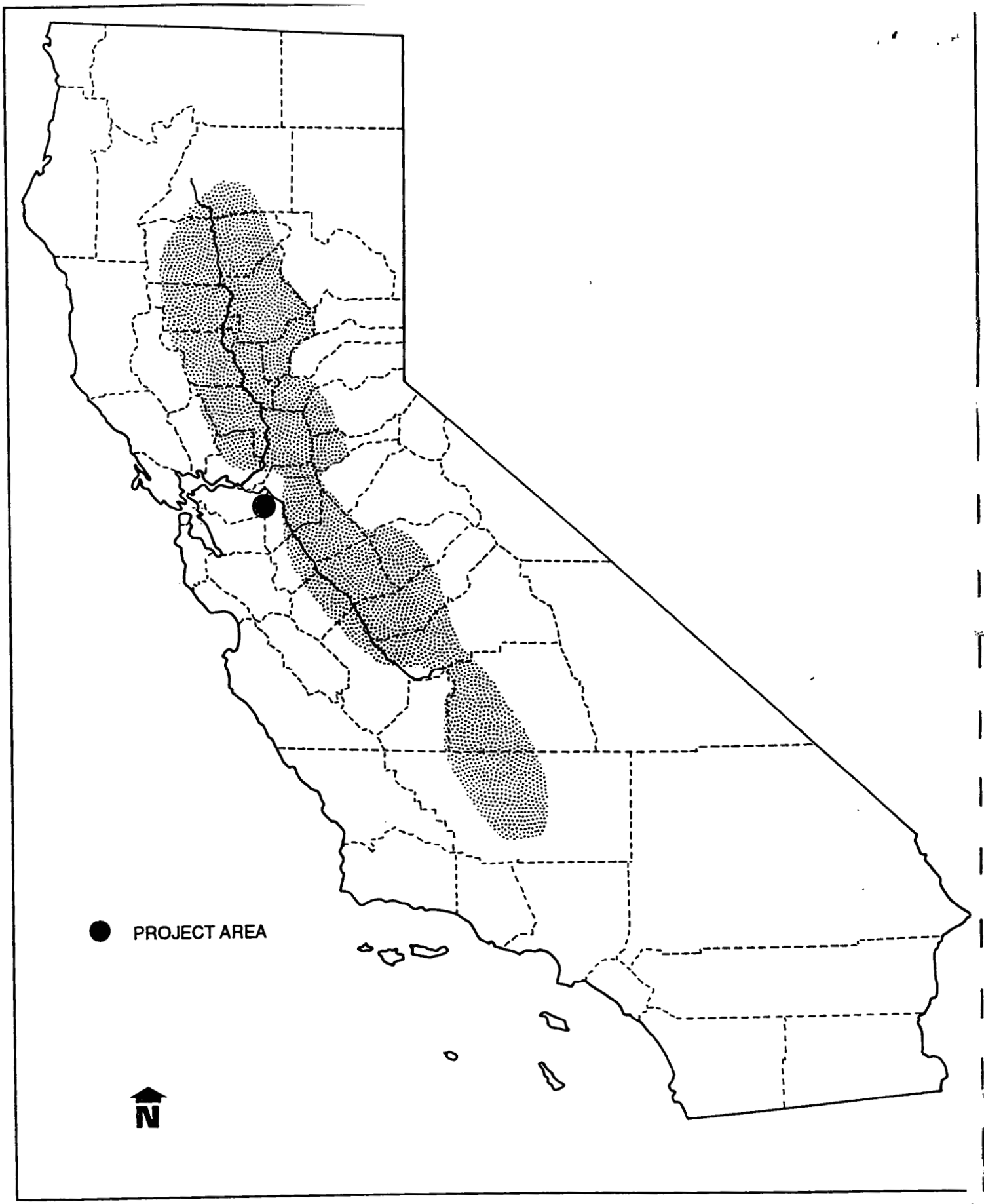
The Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB) was listed by the USFWS as threatened with critical habitat on August 10, 1980 (USFWS 1991b).

Distribution

Prior to its listing in 1980, the species was reported only from Putah Creek (Yolo and Solano counties), the Merced River (Merced County), and the American River (Sacramento County). The type-locality was reported as "Sacramento, California.". The range was described as the "lower Sacramento Valley to upper San Joaquin Valley (Linsley and Chemsak 1972).

According to NDDB (1992), the reported range now includes the following major drainages: American River (8 specific occurrences); Calaveras River (2 general reports); Cosumnes River (4 specific occurrences, 1 general report), and its tributary, Dry Creek (1 general report); Feather River (1 specific occurrence); Merced River (2 specific occurrences); Middle River (1 general report); Sacramento River (20 specific occurrences), and its historical tributary, Putah Creek (3 specific occurrences); Stanislaus River (2 specific occurrences), and Tuolumne River (2 general reports). Two widely-separated tributaries to the San Joaquin River, Bear Creek (2 general reports), and Los Banos Creek (1 specific occurrence) are also included. The distribution of VELB records among these drainages probably is more indicative of survey effort than of VELB distribution. These reports are distributed among the following counties: Butte, Colusa, Glenn, Merced, Napa, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, Tehama, Yolo, and Yuba. In general, these data support the earlier range description of "lower Sacramento Valley to the upper San Joaquin Valley."

Due to extensive work since its listing (particularly during the past five years), the reported range has been extended considerably. These new data, based upon both the presence of adults and the presence of characteristic emergence holes in elderberry (*Sambucus* spp.), are well-summarized by Barr (USFWS 1991b) and define the range as extending throughout the Central Valley, from Redding (Shasta County) to Bakersfield (Kern County) (USFWS 1991b). The eastern limit is defined by several observations from the western slope of the Sierra Nevada at elevations up to approximately 3,000 feet (USFWS 1991b). The western limit, much more difficult to define due to limited data (particularly from the southwest quadrant of the Central Valley), is defined as Cold Canyon, near Lake Berryessa (Napa County). Elevations range from approximately 30 feet on the Central Valley floor to approximately 3,000 feet in the Sierra Nevada, and to approximately 700 feet in the Coast



Distribution of the Valley Elderberry Longhorn Beetle in California

Range. In addition to those counties reported in the NDDB, VELB range is now considered to include the following counties: Shasta, Placer, El Dorado, Amador, Mariposa, Madera, Fresno, Tulare, and Kern. Cumulatively, these data support a range definition of the Central Valley, from Redding to Bakersfield, extending up to 3,000 feet on the western slope of the Sierra Nevada, and to 700 feet on the eastern slope of the Coast Range. Historically, the range of the VELB is assumed to have included riparian zones surrounding all of the major Central Valley river drainages. These riparian corridors (and associated savannahs), once much more extensive, probably offered ample habitat for the VELB.

Habitat Requirements

All stages of the VELB life cycle are closely associated with elderberry. Adults lay eggs upon the plants, after which, larvae bore in and excavate pupal cells. After pupation, new adults emerge and use elderberry for resting, foraging, and mating.

Over the past several years, there has been some speculation regarding host plant preference at the specific level. The problem has been exacerbated by taxonomic problems with *Sambucus*. Recent data indicate that VELBs infest individuals of both *S. mexicana* and *S. racemosa* var. *microbotrys*, with no distinct preference (USFWS 1991b). Similarly, there has been discussion surrounding anecdotal supposition that VELBs seem to prefer "stressed" plants. It is believed that other factors (e.g., ease of visual observation during survey efforts, and/or seasonality of plants) may have confounded this issue. Recent data indicate a clear preference (i.e., 82.5 percent) for "healthy" plants (USFWS 1991b). These data also indicate a distinct preference for larger plants (i.e., maximum branch/trunk diameter 2.5 to 30 inches; mean = 8.1 inches) (USFWS 1991b). The diameter of stems bearing recent emergence holes ranged from 1 to 8.4 inches (mean = 3.5 inches) (USFWS 1991b). Combined, these data suggest a general preference for mature, established elderberry stands; with larval utilization of healthy, somewhat younger stems (most in branches with stem diameters between 2 and 4 inches) (USFWS 1991b).

Critical Habitat

Two critical habitat zones have been established (USFWS 1991c):

1. Sacramento Zone: An area in the City of Sacramento enclosed on the north by the Route 160 freeway, on the west and southwest by the Western Pacific railroad tracks, and on the east by Commerce Circle, and its extension southward to the railroad tracks.

2. American River Parkway Zone: An area of the American River Parkway on the south bank of the American River, bounded on the north by latitude 38 37'30"N, on the west and southwest by Elmanto Drive from its junction with Ambassador Drive

to its extension to latitude 38 37'30"N, and on the south and east by Ambassador Drive and its extension north to latitude 38 37'30" N, Goethe Park, and that portion of the American River Parkway northeast of Goethe Park, west of the Jedediah Smith Memorial Bicycle Trail, and north to a line extended eastward from Palm Drive.

In addition, two "essential habitat" zones have been described:

1. American River Parkway Zone: An area within the American River Parkway, consisting of both left and right banks, extending from Nimbus Dam downstream to Arden Bar, adjacent to and encompassing previously-designated "Critical Habitat, American River Parkway Zone" (USFWS 1984)

2. Putah Creek Zone: California. Solano County. Range 2 West, Township 8 North, Sections 25, 26, 35, and 36 (USFWS 1984)

Reasons for Decline

Due to a lack of historical (and current) population data, it has not been established that the VELB is still in decline. However, habitat destruction generally is accepted as the greatest threat to the species. It has been estimated that approximately 90 percent of California riparian systems have been destroyed since the mid-1800s (USFWS 1984). Anecdotal evidence regarding "clumped" distribution suggests that VELB may be relatively poor at dispersal. If true, poor dispersal would be exacerbated by habitat fragmentation. In addition, isolation renders distinct populations much more susceptible to localized upsets due to natural (e.g., fire) or unnatural (e.g., development and/or maintenance) causes. Continued destruction of riparian habitat is considered the single greatest threat to the species.

Potential for Occurrence in the PSA

In 1984 and 1985, VELB emergence holes and adults (respectively) were reported from the Middle River, southwest of Stockton (NDDB 1992, USFWS 1991b). However, recent work in the area indicated no VELB presence, except near Dixon, Solano County (USFWS 1991b). Due to the fact that the ISDP area is within the known range of the species, and that there is a historical record of its presence proximal to the PSA, it is possible that the VELB exists within the PSA.

Although elderberries likely occur along the Feather River and one record of VELB occurrence is contained in the NDDB (1992), changes in the operation of Oroville Dam are not expected to impact this species. Elderberries typically grow on high river terraces and would not be affected by the magnitude of changes in water levels projected by DWR's modeling studies (see Appendix III).

Proposed Survey Methodology

Reconnaissance surveys will be conducted in March, when host plants are beginning to produce leaves, to determine whether elderberry plants occur in the PSA. If present, plants will be examined for evidence of VELB infestation (i.e., emergence holes). Follow-up surveys will be conducted during the adult activity season (i.e., mid-April through early June) to coincide with elderberry flowering. This will increase the likelihood of observing active adults and will allow for the detection of fresh emergence holes appearing at the onset of adult activity.

Conservancy Fairy Shrimp

Status

Currently, the Conservancy fairy shrimp (*Branchinecta conservatio*) is classified by the USFWS as a Category 1 candidate species. However, there is a proposed rule to determine endangered status for three (*Branchinecta* spp.) fairy shrimp, including the Conservancy fairy shrimp, the Californian linderiella (*Linderiella occidentalis*), and the vernal pool tadpole shrimp (*Lepidurus packardi*) in California (USFWS 1992b).

Distribution

The NDDB (1992) contains no distributional records for the Conservancy fairy shrimp, so-named in appreciation for The Nature Conservancy's protection of California vernal pool habitats (Eng *et al.* 1990). Cumulatively, it is reported from only five locations:

1. The type-locality, "Olcott Pool" (and two additional pools) at The Nature Conservancy's Jepson Prairie Preserve (11 miles south of Dixon, Solano County), from which it was collected in 1979 and 1982 (Eng *et al.* 1990);

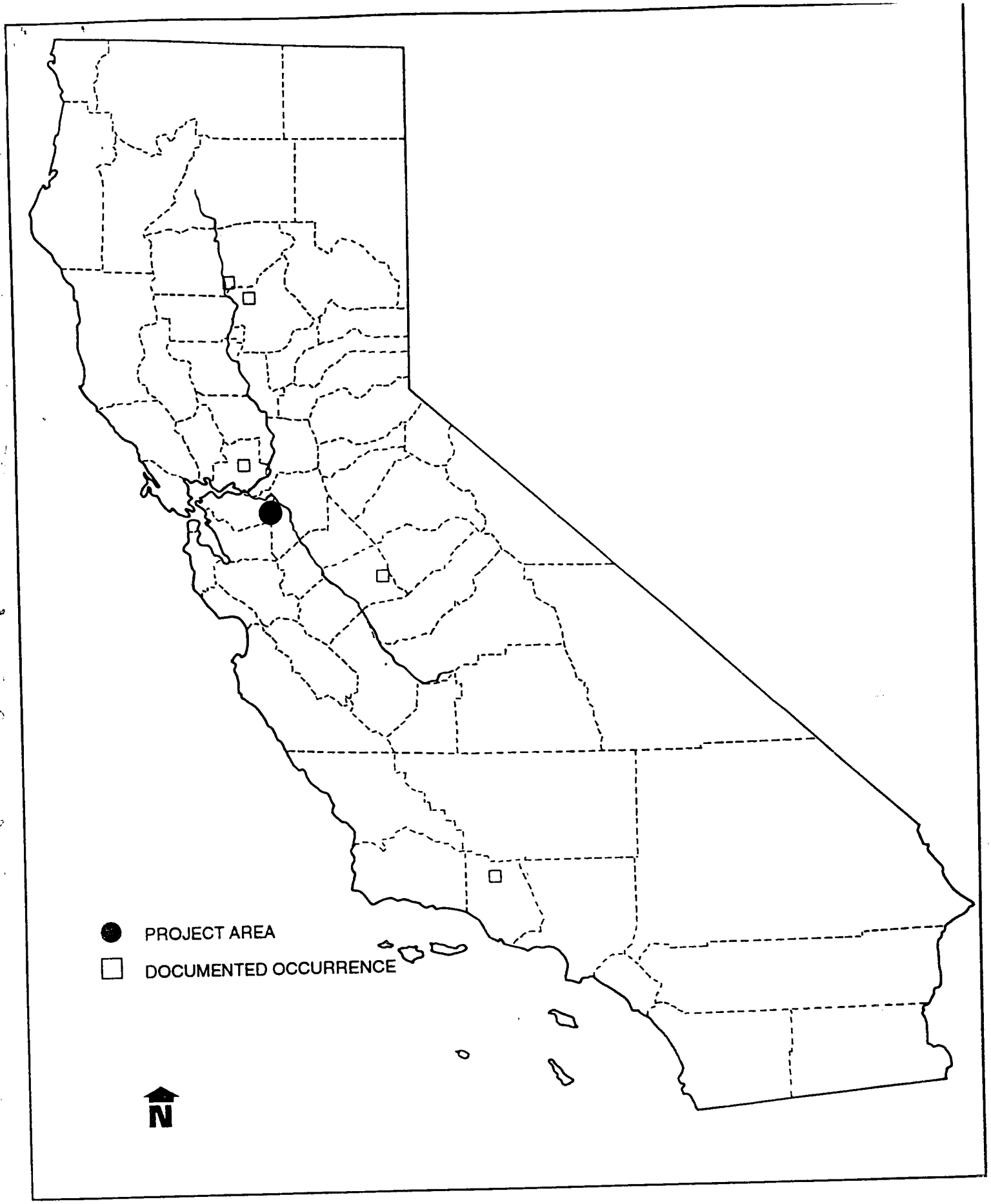
2. Seven grassland vernal pools at The Nature Conservancy's Vina Plains Preserve, Tehama County (Eng *et al.* 1990);

3. One pool at the "Flying M" Ranch, near Haystack Mountain, Merced County (Eng *et al.* 1990);

4. "Beside Keefer Road 2.4 km from California Highway 99E", Butte County (Eng *et al.* 1990); and

5. One pool in the Lockewood Valley, Ventura County (USFWS 1992b).

In 1990, Eng *et al.* described the range of the Conservancy fairy shrimp as the "grasslands of the northern two-thirds of the Central Valley spanning a north-south distance of about 300 km [186 miles], at elevations between 5 and 145 m [16-476 feet]." However, the recent report by Fugate (USFWS 1992b) of the Ventura County locality significantly expands the known range to include the entire Central Valley. Nevertheless, distribution within this range remains extremely disjunct.



Distribution of the Conservancy Fairy Shrimp in California

Habitat Requirements

The locales from which Conservancy fairy shrimp have been collected are described as "highly turbid, ephemeral water located in swales and vernal pools" (USFWS 1992b). These vernal swales and pools are created by winter/spring runoff into depressions lined with "hardpan" clay; and may last for several months before drying out. They have been more technically described as "seasonally astatic" (i.e., pools "which may fill and redry one or more times in any given year depending on the seasonal nature of precipitation and drought") (Eng *et al.* 1990). All pools reportedly supporting this species lasted "into June" (Eng *et al.* 1990).

Pools inhabited by the Conservancy fairy shrimp are rather large (Eng *et al.* 1990, USFWS 1992b). The type-locality, "Olcott Pool" at the Jepson Prairie Preserve has a surface area of approximately 4 hectares (10 acres), with a maximum depth of approximately 30 cm (12 inches) (Eng *et al.* 1990). The smallest reported pool has a surface area of approximately 1,500 square meters (0.37 acre) (Eng *et al.* 1990). Quantitative data from "Olcott Pool" and from the Vina Plains locality indicate a relatively neutral pH, with low alkalinity, conductivity, and total dissolved solids (TDS). Turbidity at "Olcott Pool" was extreme (i.e, Secchi disk visibility < 5 cm) (Eng *et al.* 1990, USFWS 1992b).

Fairy shrimp typically complete their life cycle in approximately two months (Eng pers. comm.), but depending upon species and temperature, this period may range from 2-12 weeks (Mizutani *et al.* 1991). "Nearly all fairy shrimp feed upon algae, bacteria, protozoa, rotifers, and bits of detritus" (USFWS 1992b). Eggs are either dropped at the bottom of the pond, or remain attached to the female until she dies and sinks. The thick-shelled eggs are very tolerant of adverse conditions (i.e., heat, cold, and prolonged desiccation), and hatch when the vernal swale/pool fills again with runoff (USFWS 1992b). Some eggs have been known to be viable for as long as 15 years (Balfour pers. comm.).

Critical Habitat

No critical habitat has been established for the Conservancy fairy shrimp.

Reasons for Decline

The Conservancy fairy shrimp was only recently described (Eng *et al.* 1990) from collections made in 1979 and 1982. Population estimates are inadequate to document a "decline." However, a consideration of habitat requirements and the currently documented range indicate that the species once was probably "widely distributed in large, turbid pools throughout the Central Valley" (Eng *et al.* 1990). Much suitable habitat has probably been lost to agricultural (and other) development activities since the 1800s, thus contributing to a probable corresponding decline of the species. Holland (1978, 1988) estimated that, at

the time Europeans arrived in California, there were 6 million acres of vernal pools in the Central Valley; by 1970, approximately 5.4 million acres (90 percent) had been destroyed. Holland (1988) estimated that vernal pool habitat loss continues at a rate of 2 to 3 percent per year.

In general terms, the restriction of the species to small, widely scattered locations renders individual populations extremely vulnerable to localized disturbance. Recent work by Mizutani *et al.* (1991) suggests that this species is sensitive to relatively low concentrations (i.e., 1 part per million) of cadmium and zinc, though somewhat less sensitive to lead. Sensitivity to other heavy metals (e.g., selenium) is unknown; however, in areas where local geology/hydrology permit leaching into vernal pools (e.g., drainages downstream from mine tailings or major roadways) this may represent a threat which extends to other fairy shrimp species, including the Conservancy fairy shrimp.

Potential for Occurrence in the PSA

The South Delta region lies well within the documented range of the species. While incongruous soil origin argues against the possibility that the Conservancy fairy shrimp would occur on any of the Delta islands (island soils are derived from peat accumulations and lack "hardpan" clay), it is possible that this species may occupy vernal swales and pools at the western margin of the ISDP area. Fairy shrimp have recently been located in fields cultivated for several years (Balfour pers. comm.). Tolerance for "highly turbid" waters suggests that (if agricultural chemical loading is not toxic) remnant populations might even utilize drainage ditches. This represents a potential conflict with Alternative 6 (Byron Tract Forebay Configuration), which would inundate some 2,900 acres of former grassland.

Changes in operations at Oroville Dam, and the resulting changes in water levels in the lower Feather River, would not affect this species.

Proposed Survey Methodology

Field surveys will focus on Byron Tract to determine whether ephemeral pools and swales are present within the PSA. Preliminary survey efforts will include a review of soil surveys, topographic data, and recent aerial photography (shot during the rainy season) to identify remaining vernal swales and pools.

Field surveys to sample for fairy shrimp will be conducted in areas of potential habitat identified during preliminary surveys, and in irrigation ditches and drainage channels. To ensure adequate coverage, field surveys should consist of one survey per pool per month during January, February, and March. However, adults of this species have been observed from November through early April (USFWS 1992b). Contingent upon weather conditions

and approval from the USFWS, it may be feasible to conduct field surveys through April. Fairy shrimp collected during such surveys will be identified by qualified individuals.

Alternatively, off-season (i.e., dry season) soil sampling, combined with laboratory incubation of fairy shrimp eggs has recently proven successful (Eng pers. comm., Eng *et al.* 1990). Due to the fact that specific biology for the Conservancy fairy shrimp is not well known, laboratory protocol is not well-established and/or -documented (at least in the published literature) and the selection of representative soil samples may be problematic. This method should be considered experimental and a negative result should be interpreted as "inconclusive."

Longhorn Fairy Shrimp

Status

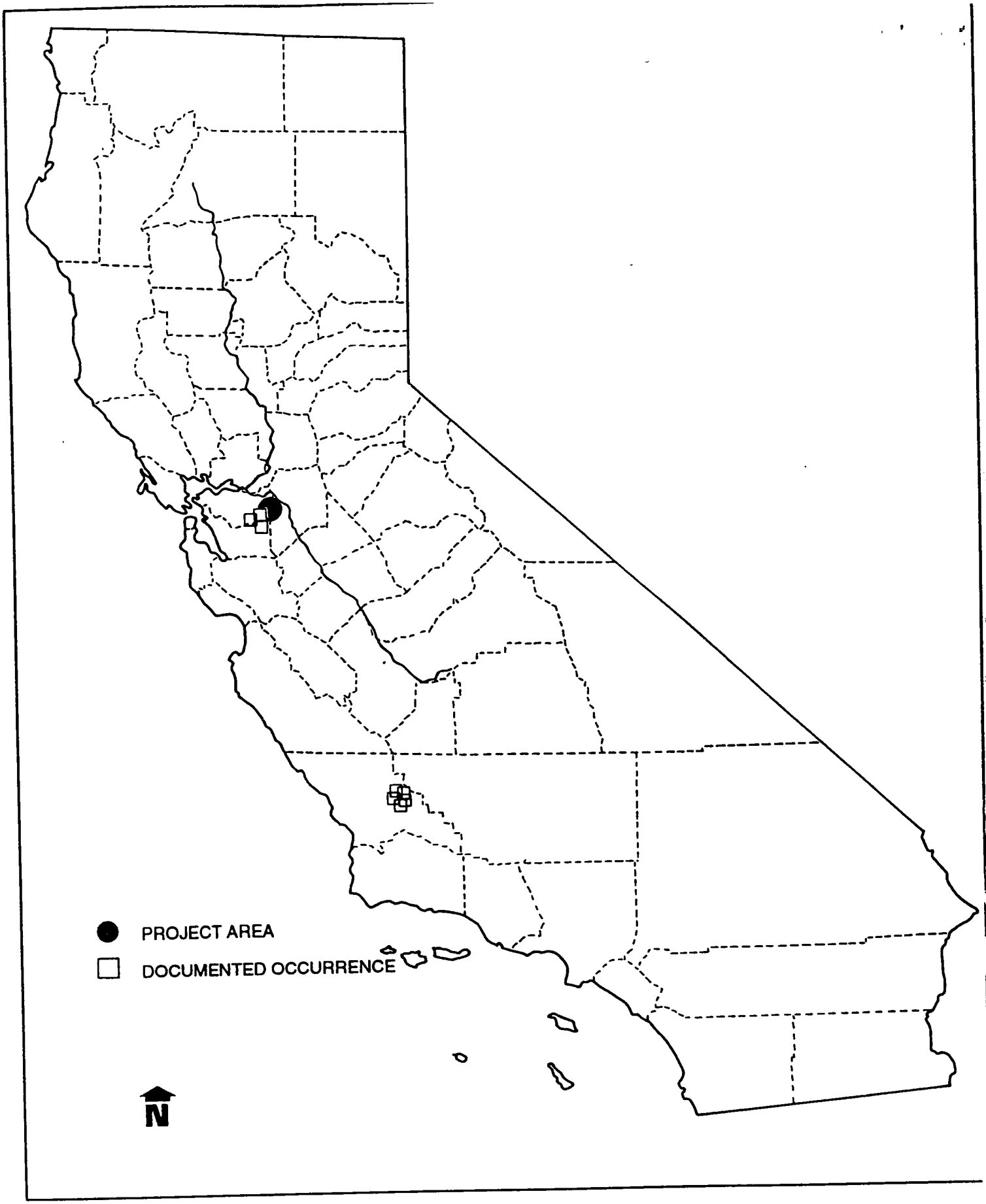
Currently, the longhorn fairy shrimp (*Branchinecta longiantenna*) is classified by the USFWS as a Category 1 candidate species. However, there is a proposed rule to determine endangered status for three (*Branchinecta* spp.) fairy shrimp, including the longhorn fairy shrimp, the Californian linderiella (*Linderiella occidentalis*), and the vernal pool tadpole shrimp (*Lepidurus packardi*) in California (USFWS 1992b).

Distribution

The NDDB (1992) reports seven distributional records for the longhorn fairy shrimp:

1. Simmler 7 1/2 minute USGS topographic quadrangle, San Luis Obispo County,
2. Byron Hot Springs 7 1/2 minute USGS topographic quadrangle, Contra Costa County,
3. Altamont and Byron Hot Springs 7 1/2 minute USGS topographic quadrangles, Alameda County,
4. Simmler quadrangle 7 1/2 minute USGS topographic quadrangle, San Luis Obispo County,
5. Simmler quadrangle 7 1/2 minute USGS topographic quadrangle, San Luis Obispo County,
6. Simmler quadrangle 7 1/2 minute USGS topographic quadrangle, San Luis Obispo County, and
7. Chimineas Ranch 7 1/2 minute USGS topographic quadrangle, San Luis Obispo County.

Eng *et al.* (1990) report type-material collections from an indeterminate number of pools (i.e., the type-locality, "other pools in the Slanted Rocks Area," and "a single pool in the Bat Rocks Area") at Souza Ranch (Contra Costa County) in 1982; one from "a rock depression near Murietta's Caves at Altamont Pass (Alameda County) in 1937; and "2 pools beside a dirt road near the northwest end of Soda Lake" (San Luis Obispo County) (no date). The USFWS (1992b) describes the Souza Ranch locations as "4 pools in the Kellogg Creek watershed." The NDDB (1992) reports five localities in the Simmler and Chimineas Ranch 7 1/2 minute topographic quadrangles (San Luis Obispo County). Eng *et al.* 1990) and USFWS (1992b) describe the San Luis Obispo County localities as 13 pools "around the



Distribution of the Longhorn Fairy Shrimp in California

western and northern boundaries of Soda Lake." Mizutani *et al.* (1991) report obtaining experimental specimens from "a turbid rain pool located between Soda Lake and California Valley, San Luis Obispo County." The description given is inadequate to distinguish this pool from those reported by Eng *et al.* (1990). Cumulatively, the longhorn fairy shrimp is reported from 18 pools in three widely disjunct locations along the eastern margin of the Coast Range, between Contra Costa and San Luis Obispo counties (approximately 210 miles), at elevations from 968 to 1,952 feet (Eng *et al.* 1990). In addition, Jones & Stokes Associates (1992) reports longhorn fairy shrimp from two locations (one in Alameda County, the other within the Kellogg Creek Watershed, Contra Costa County), near Brushy Peak.

Habitat Requirements

The longhorn fairy shrimp inhabits two quite different seasonally astatic vernal pools (i.e., "which may fill and redry one or more times during any given year depending on the seasonal nature of precipitation and drought) (Eng *et al.* 1990). According to Eng *et al.* (1990), these are: "(1) small (approximately 1 m in diameter), clear-water depression pools in sandstone outcrops, and (2) clear to moderately turbid, clay- and grass-bottomed pools (1-62 m in diameter) in shallow swales of short grass or grass and low shrub vegetation of near desert conditions." The NDDB (1992) describes the known-occurrence localities as "small, clear-water depressions in sandstone and clear-to-turbid clay-/grass-bottomed pools in shallow swales." Both pool types were "filled by winter and spring rains and may last until June (USFWS 1992b, Eng *et al.* 1990).

Water temperatures during collections of *B. longiantenna* ranged from 10-28°C (50-82°F); 10-18°C (50-64°F) in the northern locations, and 12-28°C (54-82°F) in the southern locations (Eng *et al.* 1990). In the lab, Mizutani *et al.* (1991) worked with specimens from the southern locations for several weeks at 13°C (55°F). Sandstone depression pools were not analyzed regarding water chemistry. Although observed values exhibited more variance than grassland pools sampled in other locations, the Soda Lake pools were characterized by low values for chlorides, alkalinity, and total dissolved solids (TDS) (Eng *et al.* 1990). The median observed pH was 7.2 (Eng *et al.* 1990).

Fairy shrimp typically complete their life cycle in approximately two months (Eng pers. comm.), but depending upon species and temperature, this period may range from 2-12 weeks (Mizutani *et al.* 1991). "Nearly all fairy shrimp feed upon algae, bacteria, protozoa, rotifers, and bits of detritus" (USFWS 1992b). Eggs are either dropped at the bottom of the pond, or remain attached to the female until she dies and sinks. The thick-shelled eggs are very tolerant of adverse conditions (i.e., heat, cold, and prolonged desiccation), and hatch when the vernal swale/pool fills again with runoff (USFWS 1992b). Some eggs have been known to last as long as 15 years (Balfour pers. comm.).

Critical Habitat

No critical habitat has been established for this species.

Reasons for Decline

The longhorn fairy shrimp was only recently described (Eng *et al.* 1990) from collections made in 1937 and 1982. Population estimates are inadequate to document a "decline." Consideration of habitat requirements and the currently documented range indicate that the species probably existed in small pools scattered throughout the known range (elevations of 1,000-2,000 feet along the eastern margin of the Coast Range, between Contra Costa and San Luis Obispo counties). Downstream migration into the floor of the Central Valley has not been documented and it is apparently restricted to higher elevations. Thus, available habitat may have always been somewhat limited.

In general terms, the restriction of the species to small, widely scattered locations renders individual populations extremely vulnerable to localized disturbance. Eng *et al.* (1990) report that the majority of the Soda Lake pools were within an area already under development. Recent work by Mizutani *et al.* (1991) suggests that the longhorn fairy shrimp is sensitive to relatively low concentrations (i.e., 1 part per million) of cadmium and zinc, though somewhat less sensitive to lead. Sensitivity to other heavy metals (e.g., selenium) is unknown; however, in areas where local geology/hydrology permit leaching into vernal pools (e.g., drainages downstream from mine tailings or major roadways) this may represent a threat which extends to other fairy shrimp species.

Potential for Occurrence in the PSA

This species is known from locations within 10 miles (and directly upstream) of the western margin of the South Delta. The Kellogg Creek watershed, from which the longhorn fairy shrimp has been recently reported (Jones & Stokes Associates 1992), drains into a channel that passes just south of Byron. Although downstream migration to the Central Valley floor has not been documented, and habitat associations with "clear to moderately turbid" waters argue against its utilization of disturbed areas and drainage ditches, existing work is inadequate to discount downstream occurrence. While incongruous soil origin argues against the possibility that longhorn fairy shrimp would occur on any of the Delta islands (island soils are derived from peat accumulations and lack "hardpan" clay), it is possible that fairy shrimp may occupy vernal swales and pools at the western margin of the Delta. Fairy shrimp have recently been located in fields that have been cultivated for several years (Balfour pers. comm.). Therefore, it is considered possible that this species occurs within the ISDP area. This represents a potential conflict with Alternative 6 (Byron Tract Forebay Configuration) which would inundate some 2,900 acres of former grassland.

Changes in operations of Oroville Dam, and the resulting changes in water levels in the lower Feather River, would not affect this species.

Proposed Survey Methodology

Field surveys will focus on Byron Tract to determine whether ephemeral pools and swales are present within the PSA. Preliminary survey efforts will include a review of soil surveys, topographic data, and recent aerial photography (shot during the rainy season), to identify remaining vernal swales and pools.

Field surveys to sample for fairy shrimp will be conducted by experienced personnel in areas of potential habitat identified during preliminary surveys, and in irrigation ditches and drainage channels. To ensure adequate coverage, field surveys should consist of one survey per pool per month during January, February, and March. However, longhorn fairy shrimp adults have been observed from late December through late April (USFWS 1992b). Contingent upon weather conditions and approval from the USFWS it may be feasible to conduct field surveys during this extended period. Fairy shrimp collected during such surveys will be identified by qualified personnel.

Alternatively, off-season (i.e., dry season) soil sampling, combined with laboratory incubation of fairy shrimp eggs has recently proven successful (Eng pers. comm., Eng *et al.* 1990). However, due to the fact that specific biology for this species is not well known, laboratory protocol is not well-established and/or -documented (at least in the published literature), and the selection of representative soil samples may be problematic. This method should be considered experimental and a negative result should be interpreted as "inconclusive."

Vernal Pool Fairy Shrimp

Status

Currently, the vernal pool fairy shrimp (*Branchinecta lynchi*) is classified by the USFWS as a Category 1 candidate species. However, there is a proposed rule to determine endangered status for three (*Branchinecta* spp.) fairy shrimp, including the vernal pool fairy shrimp, the Californian linderiella (*Linderiella occidentalis*), and the vernal pool tadpole shrimp (*Lepidurus packardi*) in California (USFWS 1992b).

Distribution

The NDDB (1992) contains no distribution records for vernal pool fairy shrimp. Eng *et al.* (1990) provide a discussion of the range, but describe only the following specific locations:

1. Slanted Rocks area at Souza Ranch (Contra Costa County), at elevation 290 m (951 feet) (i.e., the type-locality);
2. Vina Plains (Tehama County);
3. Mountain Grasslands north of Santa Barbara (Santa Barbara County);
4. Santa Rosa Plateau (Riverside County);
5. Skunk Hollow, near Rancho California (Riverside County);
6. Soda Lake (San Luis Obispo County);
7. Pixley (Tulare County); and
8. Haystack Mountain (Merced County).

Jones & Stokes Associates (1992) report this species from two locations (one in Alameda County, and one within the Kellogg Creek watershed in Contra Costa County) near Brushy Peak. In addition, Eng *et al.* (1990) provide more general geographic references to the following locations:

1. 11 additional paratype collections from Contra Costa County;
2. 1 additional paratype collection from Glenn County;
3. 1 additional paratype collection from Merced County;
4. 4 additional paratype collections from Sacramento County; and
5. 1 additional paratype collection from Tehama County.

Specific references are presented as discrete points on the distribution map, while counties are shaded for the more general references. Cumulatively, Eng *et al.* (1990) report vernal pool fairy shrimp from 29 pools, and provide the following verbal description of the range:

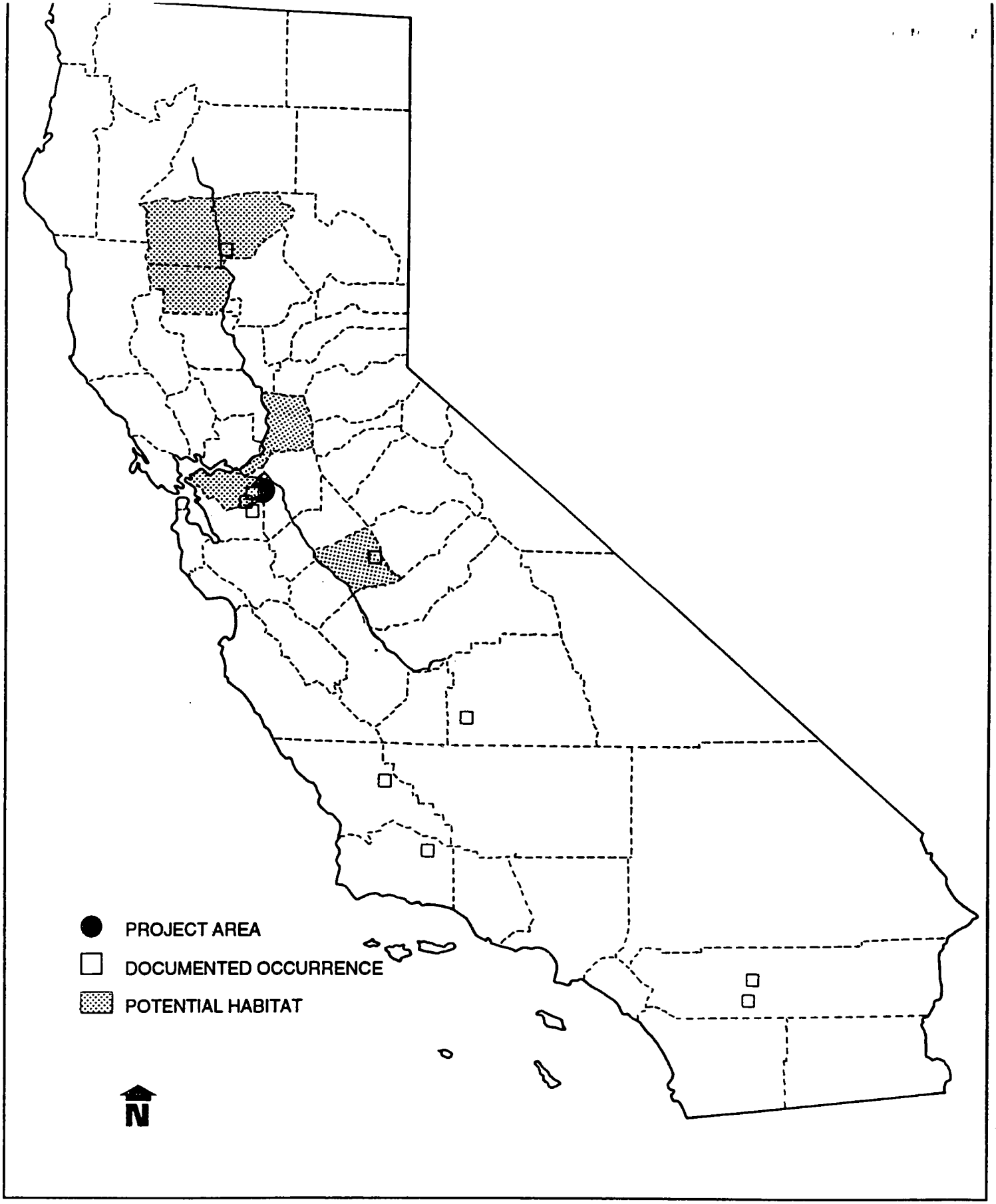
> " ... *from the Vina Plains of Tehama County in the northern Central Valley, through most of the length of the Central Valley and eastern margin of the Central Coast Mountains Region, to the mountain grasslands north of Santa Barbara, a total of 615 km [382 miles]. Several disjunct populations are located 285 km [177 miles[further south on the Santa Rosa Plateau and in Skunk Hollow near Rancho California, Riverside County. The species was collected at elevations from 10-1,159 m [33-3802 feet].*"

The USFWS (1992b) reports a total of 30 pools, but provides essentially the same range description.

Habitat Requirements

Vernal pool fairy shrimp inhabit two quite different seasonally astatic pools (i.e., "which may fill and redry 1 or more times during any given year depending on the seasonal nature of precipitation and drought) with "clear to tea-colored water" (Eng *et al.* 1990, USFWS 1992b). According to Eng *et al.* (1990), these are: (1) small, usually less than 0.5 m (20 inches) in diameter, clear-water depression pools in sandstone outcrops; and (2) the more common "grassed (occasionally mud-bottomed) swale, earth slump, or basalt-flow depression pools in unplowed grasslands." The grass- or mud-bottomed pools ranged in size from only 20 square meters (215 square feet) to more than 10 hectares (25 acres). Water quality data for one such pool indicate "that this species occurs at temperatures between about 6 and 20°C [43-68°F] in soft, poorly-buffered waters ([i.e.,] low TDS [total dissolved solids], conductivity, alkalinity, and chloride) with a pH averaging about 7.0" (Eng *et al.* 1990). Water quality data for sandstone outcrop pools were unavailable, but pH was reported to range between 5.5 and 7.0 (Eng *et al.* 1990).

Fairy shrimp typically complete their life cycle in approximately two months (Eng pers. comm.), but depending upon species and temperature, this period may range from 2-12 weeks (Mizutani *et al.* 1991). "Nearly all fairy shrimp feed upon algae, bacteria, protozoa, rotifers, and bits of detritus" (USFWS 1992b). Eggs are either dropped at the bottom of the pond, or remain attached to the female until she dies and sinks. The thick-shelled eggs are very tolerant of adverse conditions (i.e., heat, cold, and prolonged desiccation), and hatch when the vernal swale/pool fills again with runoff (USFWS 1992b). Some eggs have been known to last as long as 15 years (Balfour pers. comm.).



Distribution of the Vernal Pool Fairy Shrimp in California

Critical Habitat

No critical habitat has been designated for the vernal pool fairy shrimp.

Reasons for Decline

The vernal pool fairy shrimp was only recently described (Eng *et al.* 1990) from collections made in 1982, and population estimates are inadequate to document a "decline." Although the species ranges over a broad area, locations are rather scattered, and the species "was not abundant anywhere"(Eng *et al.* 1990). When co-occurring with other species, it was never numerically dominant (Eng *et al.* 1990).

Consideration of habitat requirements and the currently documented range suggest that the species once was probably widely distributed in grassland ephemeral pools throughout the Central Valley and in the margins of bordering mountain ranges. Much suitable habitat has been lost to agricultural and other development activities since the 1800s, thus contributing to a probable corresponding decline of the species. Holland (1978, 1988) estimated that, at the time Europeans arrived in California, there were 6 million acres of vernal pools in the Central Valley; by 1970, approximately 5.4 million acres (90 percent) had been destroyed. Holland (1988) estimated that vernal pool habitat loss continues at a rate of 2 to 3 percent per year. Eng *et al.* (1990) reported that populations at Pixley (Tulare County), Haystack Mountain (Merced County), Sacramento County, and the Vina Plains (Tehama County) are essentially isolated by surrounding agriculture; and that the Souza Ranch (Contra Costa County), Sacramento County, and Soda Lake (San Luis Obispo County) populations are threatened by development.

In general terms, the restriction of the species to small, widely scattered locations renders individual populations extremely vulnerable to localized disturbance. Recent work by Mizutani *et al.* (1991) suggests that the vernal pool fairy shrimp is sensitive to relatively low concentrations (i.e., 1 part per million) of cadmium and zinc, though somewhat less sensitive to lead. Sensitivity to other heavy metals (e.g., selenium) is unknown; however, in areas where local geology/hydrology permit leaching into vernal pools (e.g., drainages downstream from mine tailings or major roadways) this may represent a threat which also extends to other fairy shrimp species.

Potential for Occurrence in the PSA

The Delta lies well within the documented range of the species, and a recent report (Jones & Stokes Associates 1992) indicates vernal pool fairy shrimp from two proximal locations, one within the Kellogg Creek watershed. While incongruous soil origin argues against the possibility that this species would occur on any of the Delta islands (island soils are derived from peat accumulations and lack "hardpan" clay), it is possible that fairy shrimp may

occupy vernal swales and pools at the western margin of the Delta. Fairy shrimp have recently been located in fields that have been cultivated for several years (Balfour pers. comm.), and have been collected from elevations as low as 10 feet (Eng *et al.* 1990). This represents a potential conflict with Alternative 6 (Byron Tract Forebay Configuration), which would inundate some 2,900 acres of former grassland.

Changes in operations of Oroville Dam, and the resulting changes in water levels in the lower Feather River, would not affect this species.

Proposed Survey Methodology

Surveys will concentrate on Byron Tract to determine whether ephemeral pools and swales are present. Preliminary survey efforts will include a review of soil surveys, topographic data, and recent aerial photography (shot during the rainy season), in order to identify remaining vernal swales and pools.

Field surveys to sample for fairy shrimp will be conducted by experienced personnel in areas of potential habitat identified during preliminary surveys and in irrigation ditches and drainage channels. To ensure adequate coverage, field surveys typically should consist of one survey per pool per month during January, February, and March. However, vernal pool fairy shrimp adults have been observed from early December through early May (USFWS 1992b). Contingent upon weather conditions and approval by the USFWS it may be feasible to conduct field surveys during this extended period. Fairy shrimp collected during such surveys will be identified by qualified personnel.

Alternatively, off-season (i.e., dry season) soil sampling, combined with laboratory incubation of fairy shrimp eggs has recently proven successful (Eng pers. comm., Eng *et al.* 1990). However, due to the fact that specific biology for this species is not well known, laboratory protocol is not well-established and/or -documented (at least in the published literature), and the selection of representative soil samples may be problematic. This method should be considered experimental and a negative result should be interpreted as "inconclusive."

San Joaquin Dune Beetle

Status

The San Joaquin dune beetle (*Coelus gracilis*) is classified by the USFWS as a Category 1 candidate species. In 1978, there was a proposal to list the beetle as "threatened, with critical habitat" (USFWS 1978), but the rule was not adopted.

Distribution

The NDDB (1992) reports 5 specific occurrences for the San Joaquin dune beetle:

1. T16S, R13E, Portions of Sections 9 and 10, Monocline Ridge USGS 7 1/2 minute topographic quadrangle, Fresno County, elevation 800 feet. This record matches the description "Fresno County, Ciervo Hills, 18 mi SW Mendota," reported by Doyen (1976). In 1978, this area was proposed as the "Monocline Ridge Zone" of "critical habitat" (USFWS 1978).

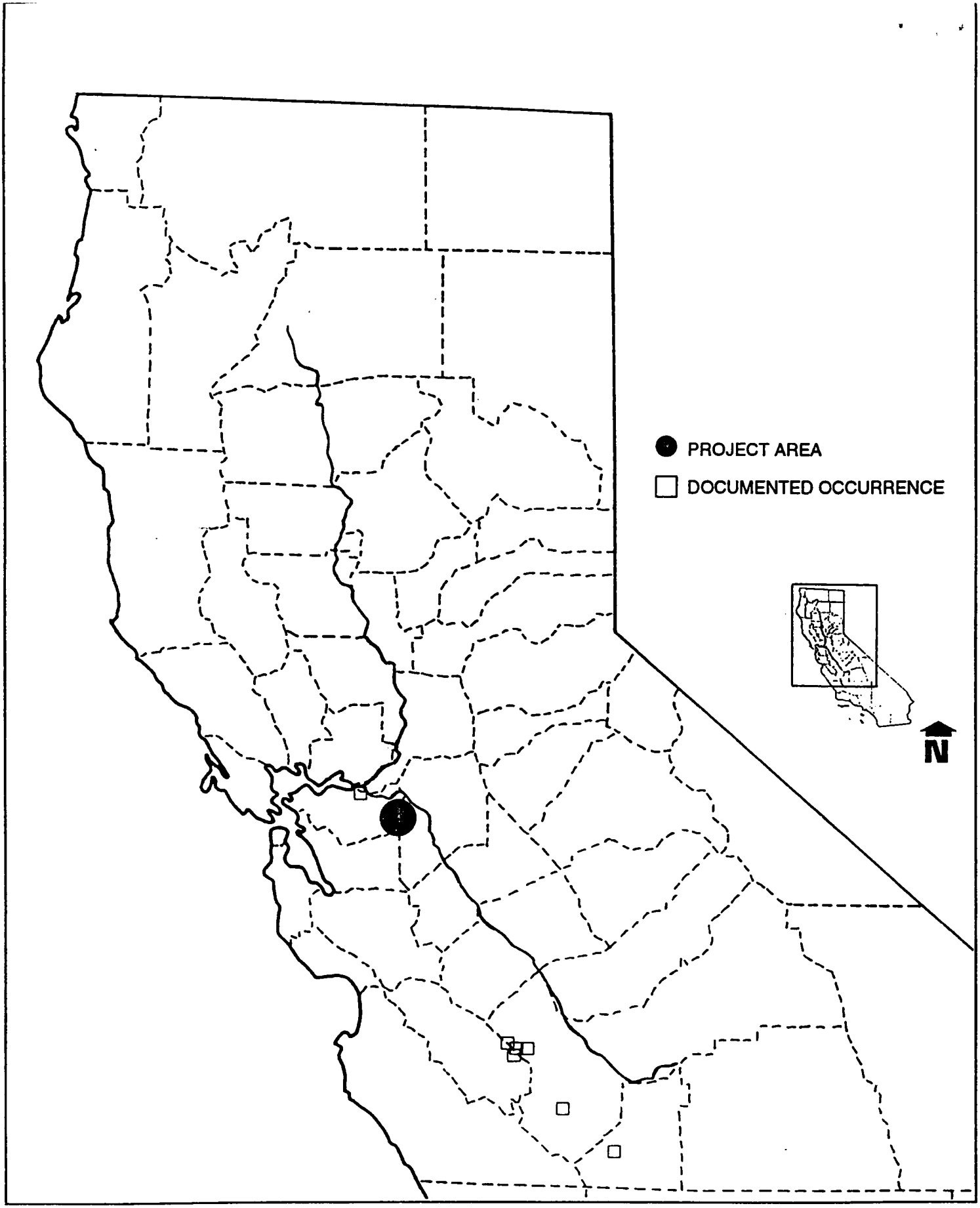
2. T15S, R11E, Portions of Sections 22, 23, 27, and 26, Tumey Hills and Panoche USGS 7 1/2 minute topographic quadrangles, Fresno and San Benito counties, elevation 1,200 feet. With the exception of there being no reference to San Benito County, this record also matches the description "Fresno County, Ciervo Hills, 18 mi SW Mendota," reported by Doyen (1976). In 1978, this area was proposed as the "Panoche Zone" of "critical habitat" (USFWS 1978).

3. T21S, R15E, Section 26, Kreyenhagen Hills 7 1/2 minute topographic quadrangle, Fresno County, elevation 1,100 feet. This record matches the description "Fresno County, ... Jacalitos Canyon, 5 air mi S Coalinga," reported by Doyen (1976). In 1978, this area was proposed as the "Jacalitos Zone" of "critical habitat" (USFWS 1978).

4. T22S, R19E, Portions of Sections 30 and 31, Los Viejos 7 1/2 minute topographic quadrangle, Kings County, elevation 350 feet. This record matches the description "Kings County, Kettleman Hills, 2 mi SW Kettleman City," reported by Doyen (1976). In 1978, this area was proposed as the "Los Medanos Zone" of "Critical Habitat" (USFWS 1978).

5. T02N, R02E, Portion of Section 18, Antioch North 7 1/2 minute topographic quadrangle, Contra Costa County, elevation 10 feet. This record matches the description "Contra Costa County, Antioch" (also reported as "Contra Costa County, 2 mi E Antioch," by Doyen (1976).

The last record represents the type-locality, the Antioch Dunes, from which Van Dyke first collected the San Joaquin dune beetle in April, 1938 (Doyen 1976). In November, 1974, Opler again observed this species at this locale (NDDB 1992), but it is believed to have since been extirpated at Antioch (Doyen 1976) due to "habitat alteration" (NDDB 1992). The distribution map defines the known range of the San Joaquin dune beetle from these records.



Distribution of the San Joaquin Dune Beetle in California

Habitat Requirements

Doyen (1976) reports that *Coelus* spp. require an "extremely" sandy substrate, in which adults and larvae spend the majority of their time. Larval development, through pupation, occurs exclusively in the sand. Adults, extremely fossorial, typically are found 5-10 cm under the surface, usually under the canopy of various herbs and shrubs, but occasionally in open sand. No specific plant associations are reported for *Coelus* spp., but the San Joaquin dune beetle is reported to take refuge under the canopy of "winter ephemeral plants." They are known to use extremely small patches of favorable habitat. Populations of San Joaquin dune beetles are restricted to small sand dunes isolated along the western edge of the San Joaquin Valley. These dunes are believed to represent the remains of sand beaches which bordered prehistoric intrusions of the Pacific Ocean into what is now the San Joaquin Valley. With the exception of the Antioch Dunes, which are believed to represent the northern extension of a once large inland desert (USFWS 1980), geologic uplift has raised the San Joaquin Valley sand dunes several hundred feet above the Valley floor, but erosion has restricted their size.

Colonization of the Antioch Dunes may have occurred secondarily by downstream migration in the San Joaquin River drainage (Doyen 1976). The lack of specific preferred plant associations and the hypothesized secondary colonization of the Antioch Dune system indicate there is no strict preference regarding relict coastal versus desert dune systems. Thus, it is possible that this species may have exploited riparian riverine dune systems as well.

Critical Habitat

No critical habitat has been established for the San Joaquin dune beetle. In 1978, four "critical habitat" zones (i.e., locations 1-4, above) were proposed (USFWS 1978), but the proposed rule was not adopted. However, the type-locality (i.e., the Antioch Dunes), from which it is now believed to have been extirpated, is legally protected as critical habitat for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980).

Reasons for Decline

Due to the lack of population estimates, decline of this species is not documented. Distribution of the San Joaquin dune beetle is limited to a few relatively small (250-10,000 square meters) dune systems along the western edge of the San Joaquin Valley (Doyen 1976). The restricted size (due to the natural processes of geologic uplift and subsequent erosion) and fragmentation of available habitat exacerbates the poor dispersal abilities hypothesized for the genus (Doyen 1976) (and reported for *C. ciliatus* by Doyen and Slobodchikoff 1984). However, the possibility of secondary colonization, such as is

hypothesized for *C. gracilis* at the Antioch Dunes, suggests that migration within drainage systems (probably aided by water transport) may represent a viable means of dispersal. This possibility is supported by the lack of reported affinities and preferred plant associations. In this case, successful dispersal would be dependent upon opportunistic exploitation of encountered suitable habitat, and it is possible that the species exists (or once did) within suitable sandy habitats remaining on the floor of the San Joaquin Valley (e.g., sandy mush) (Andrews pers. comm.). Historically, habitat destruction due to agricultural development, flood control, and water management in the San Joaquin Valley have reduced the availability of such potentially exploitable habitat, and thereby, probably restricted dispersal of the species.

The apparent extirpation of the San Joaquin dune beetle from the Antioch Dunes, reported by Doyen (1976) prior to their protection in 1980, represents a significant setback for the species. Ironically, Hagen (1986) has subsequently attributed the extirpation of another dune-inhabiting species of concern (i.e., Sacramento anthicid beetle [*Anthicus antiochensis*]) to "overstabilization." According to Doyen (1976), dune habitats near Mendota, and especially Kettleman City were heavily used by off-road vehicles, and *Coelus* populations there were threatened. In addition, the Jacalitos Canyon site, approximately 250 square meters in size, supported "only a few hundred individuals." Current status of these locales is unknown.

Potential for Occurrence in the PSA

Due to the lack of suitable relict dune habitat, the potential for occurrence of the San Joaquin dune beetle in the ISDP area is considered unlikely. In general, the level of disturbance in the Delta is believed to preclude the possibility of suitable remaining habitat. Despite extensive work in the area, this habitat has not been reported, and preliminary reconnaissance surveys have identified none. Although the species may have the ability to utilize dune formations of various origins supporting various plant associations, its poor dispersal capabilities suggest that its ability to exploit recently-formed and/or temporary dune locations (e.g., dredge spoils disposal sites), and disturbed sandy habitats is minimal. However, Doyen (1976) reports that *Coelus* are capable of utilizing extremely small areas of suitable habitat.

Proposed Survey Methodology

Field surveys are not proposed for this species; however, the presence of relict dune habitat, if any, will be noted during surveys for other species. It is important to note that such habitat should constitute true relict dune (including riverine deposits), and not recently formed and/or disturbed sandy habitat. None is expected to be found.

Should true relict dune be identified (regardless of size), follow-up surveys will be conducted during the known adult activity season of the San Joaquin dune beetle, reported as November through April. In undisturbed sites, experienced workers may be able to distinguish characteristic furrows created as the beetles occasionally burrow (horizontally) from under the vegetative canopy out into open sand. However, the appearance of such furrows is unreliable, and their absence should not be utilized to support a negative survey result. Instead, workers should excavate around the stems of winter ephemeral plants (within the shadow of the canopy) to an estimated depth of 5-10 cm. Should individuals be located, they will be identified by qualified personnel.

Vernal Pool Tadpole Shrimp

Status

Currently, the vernal pool tadpole shrimp (*Lepidurus packardi*) is categorized by the USFWS as a Category 1 candidate species. However, there is a proposed rule to determine endangered status for three (*Branchinecta* spp.) fairy shrimp, the Californian linderiella (*L. occidentalis*), and the vernal pool tadpole shrimp in California (USFWS 1992b).

Distribution

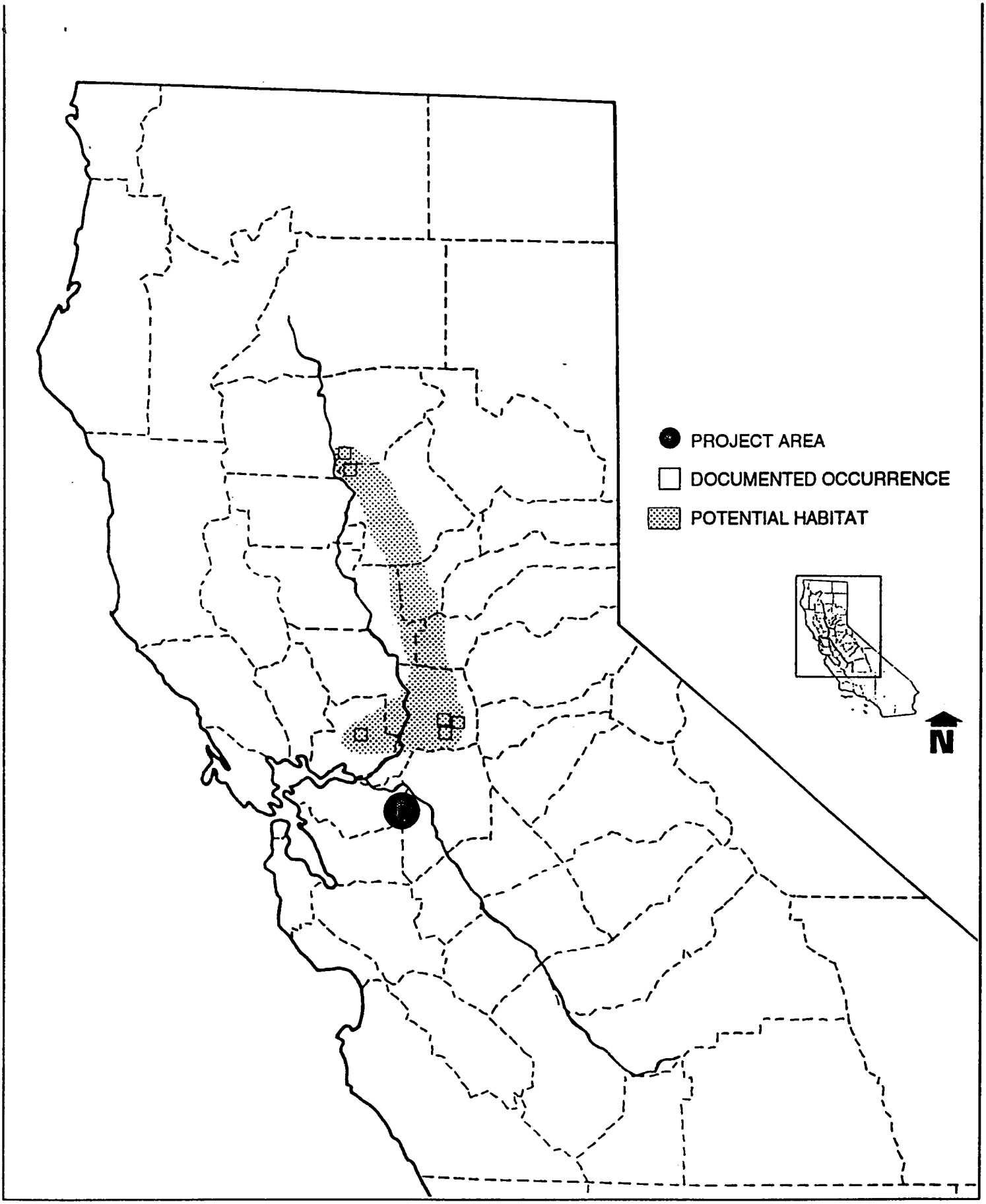
The NDDB (1992) provides no distribution records for the vernal pool tadpole shrimp. The USFWS (1992b) provides a discussion of the range (presented below), but describes only the following specific locations: 1.) "Vina Plains in Butte County;" 2.) "Mather Air Force Base area, of Sacramento County;" and 3.) "Olcott Pool," at The Nature Conservancy's Jepson Prairie Preserve (11 miles south of Dixon, Solano County). However, Ahl (1991) reports working with this species from the Vina Plains in Tehama County, and a recent survey revealed vernal pool tadpole shrimp at the Prairie City State Vehicular Recreation area (southeast of Sacramento, Sacramento County) (University of San Diego 1990). It is also reported from nearby "Florin Park" and "several other sites in the Sacramento area" (University of San Diego 1990). Thus, the following specific geographic references are provided in the literature:

1. Vina Plains (Tehama County);
2. Vina Plains (Butte County);
3. Mather Air Force Base area (Sacramento County);
4. Prairie City State Vehicular Recreation Area (Sacramento County);
5. Florin Park (Sacramento County); and
6. Olcott Pool (Solano County).

According to the USFWS (1992b):

> "*The vernal pool tadpole shrimp is found at 14 vernal pool complexes in the Sacramento Valley from the Vina Plains in Butte County [south to] south of the Sacramento area in Sacramento County and west to the Jepson Prairie region of Solano County.*"

Elevational data are not reported, but descriptions of the same localities provided for other species indicate a minimum elevation of approximately 16 feet, at "Olcott Pool." An approximation of this verbal description is presented on the distribution map; specific geographic references are presented as discrete points.



Distribution of the Vernal Pool Tadpole Shrimp in California

Habitat Requirements

The USFWS (1992b) described pools inhabited by vernal pool tadpole shrimp as "most commonly located in grass-bottomed swales of unplowed grasslands in old alluvial soils underlain by hardpan, or in mud-bottomed pools containing highly turbid water." All may be described as "seasonally astatic," as used by Eng *et al.* (1990) (i.e., pools "which may fill and redry one or more times in any given year depending on the seasonal nature of precipitation and drought."). They are filled by winter and spring rains, and may last until June (USFWS 1992b). Ahl (1991) reported that pools at Vina Plains (Tehama County) were dry by May. Pool size varies from 5 square meters [54 square feet] (USFWS 1992b) to 9 acres (i.e., "Olcott Pool," as described by Eng *et al.* (1990). Pools analyzed at Jepson Prairie (Solano County) and Vina Plains (Butte County) exhibited neutral pH and very low values for conductivity, total dissolved solids (TDS), and alkalinity (USFWS 1992b).

Critical Habitat

No critical habitat for has been designated for this species.

Reasons for Decline

Although vernal pool tadpole shrimp have been observed since the late 1800s, population estimates are inadequate to document a "decline." However, consideration of habitat requirements and the currently documented range indicate that the species was probably widely distributed in pools throughout the Sacramento Valley. Much suitable habitat has been lost to agricultural and other development activities since the 1800s, thus contributing to a probable corresponding decline of the species. Holland (1978, 1988) estimated that, at the time Europeans arrived in California, there were 6 million acres of vernal pools in the Central Valley; by 1970, approximately 5.4 million acres (90 percent) had been destroyed. Holland (1988) estimated that vernal pool habitat loss continues at a rate of 2 to 3 percent per year.

In general terms, the restriction of the species to small, widely scattered locations renders individual populations extremely vulnerable to localized disturbance. Recent work by Mizutani *et al.* (1991) suggests that the longhorn fairy shrimp (*Branchinecta longiantenna*) is sensitive to relatively low concentrations (i.e., 1 part per million) of cadmium and zinc, though somewhat less sensitive to lead. Sensitivity to other heavy metals (e.g., selenium) is unknown; however, in areas where local geology/hydrology permit leaching into vernal pools (e.g., drainages downstream from mine tailings or major roadways) this may also represent a threat to the vernal pool tadpole shrimp.

Potential for Occurrence in the PSA

The Delta lies just outside the documented range of the vernal pool tadpole shrimp. Its range approaches the northeastern reaches of the Delta south of Sacramento (Sacramento County), and the northwest quadrant of the Delta south of Dixon (Solano County). While incongruous soil origin argues against the possibility that vernal pool tadpole shrimp would occur on any of the Delta islands (island soils are derived from peat accumulations and lack "hardpan" clay), it is possible that this species may occupy vernal swales and pools at the northeastern and western margin of the Delta. Fairy shrimp have recently been located in fields that have been cultivated for several years (Balfour pers. comm.). Their tolerance for "clear to highly turbid" waters (USFWS 1992b) suggest that (if agricultural chemical loading is not toxic) remnant populations may even use drainage ditches. Eng (pers. comm.) indicates it is possible that the vernal pool tadpole shrimp may utilize "roadside ditches."

The wide tolerance for habitat types, and the proximity of the known range of the vernal pool tadpole shrimp to the Delta, suggest that its occurrence in the ISDP area is possible. It has been collected from elevations as low as 16 feet. Should it occur in the PSA, this would represent a potential conflict with Alternative 6 (Byron Tract Forebay Configuration), which would inundate some 2,900 acres of former grassland.

Proposed Survey Methodology

Field surveys will concentrate on Byron Tract to determine whether ephemeral pools and swales are present. Preliminary survey efforts will include a review of soil surveys, topographic data, and recent aerial photography (shot during the rainy season), to identify remaining vernal swales and pools.

Field surveys to sample for tadpole shrimp will be conducted ~~by experienced personnel~~ in areas identified during preliminary surveys and in irrigation ditches and drainage channels. To ensure adequate coverage, field surveys should consist of one survey per pool per month during January, February, and March. Vernal pool tadpole shrimp have been observed from late December to late May at Vina Plains, Tehama County (Ahl 1991). Adults first appeared during mid-January, but Ahl (1991) reported that accomplishment of sexual maturity in populations was coincident with reaching a carapace length of 12 mm. A preliminary review of his data indicates that this mean length was not attained in all of the sampled populations until the third week in January. These data may be somewhat skewed by the fact that the species is multivoltine (Ahl 1991) and juveniles were present throughout the life of the ponds. Conversely, University of San Diego (1990) reports that populations at Prairie City State Vehicular Recreation Area (Sacramento County) matured slowly and were "quite long-lived." However, these observations were based upon only two samples collected February 2 and March 17. In summary, the adult activity period for vernal pool tadpole shrimp is documented as late January to late May (Ahl 1991). Contingent upon weather conditions and approval by the USFWS it may be feasible to conduct field surveys

through April. Tadpole shrimp collected during such surveys will be identified by qualified individuals.

Alternatively, off-season (i.e., dry season) soil sampling, combined with laboratory incubation of tadpole shrimp eggs has recently proven successful (Ahl 1991). Laboratory protocol is better-established for vernal pool tadpole shrimp than for more recently described fairy shrimp species. However, the field selection of representative soil samples may remain problematic, and a negative result should be interpreted as "inconclusive."

Californian Linderiella

Status

Currently, the Californian linderiella (*Linderiella occidentalis*) is categorized by the USFWS as a Category 1 candidate species. However, there is a proposed rule to determine endangered status for three (*Branchinecta* spp.) fairy shrimp, the Californian linderiella (*L. occidentalis*), and the vernal pool tadpole shrimp (*Lepidurus packardi*) in California (USFWS 1992b).

Distribution

The NDDB (1992) provides no distribution records for Californian linderiella. Eng *et al.* (1990) provide a discussion of the range (presented below), but describe only the following specific locations:

1. Stanford University (i.e., the type-locality) (Santa Clara County);
2. Boggs Lake (Lake County);
3. "east of Red Bluff (Tehama County);" and
4. "east of Madera (Madera County)."

In addition, Patton (1984) found Californian linderiella in approximately four distinct locations ranging over 66 km [41 miles] in Butte and Tehama counties. Dubbs (1987) reports this species from two pools southeast of Sacramento (Sacramento County). A recent survey revealed Californian linderiella at the Prairie City State Vehicular Recreation area (southeast of Sacramento, Sacramento County), and it is reported from "Florin Park," and "Phoenix Field Ecological Preserve," nearby (University of San Diego 1990). Jones & Stokes Associates (1992) reports Californian linderiella from two locations near Brushy Peak (Alameda and Contra Costa counties), one within the Kellogg Creek watershed.

Eng *et al.* (1990) offer this description of the distribution of the 39 sites they report to support this species:

> "*About half of these are located along the east side of the Central Valley from east of Red Bluff (Tehama County) to east of Madera (Madera County) at elevations between 40 and 168 m [131-551 feet]. The species crosses the Central Valley in the Sacramento area and is found in the Central and South Coast Mountains Regions from Boggs Lake, 90 km [56 miles] north of San Francisco Bay in Lake County, south, in a series of disjunct populations, to Riverside County, at elevations of 10-1,159 m [33-3800 feet].*"

An approximation of this verbal description is presented on the distribution map; documented occurrences are presented as discrete points.

Habitat Requirements

Californian linderiella inhabits three different types of seasonally astatic pools, which may fill and redry one or more times during any given year depending on the seasonal nature of precipitation and drought (Eng *et al.* 1990):

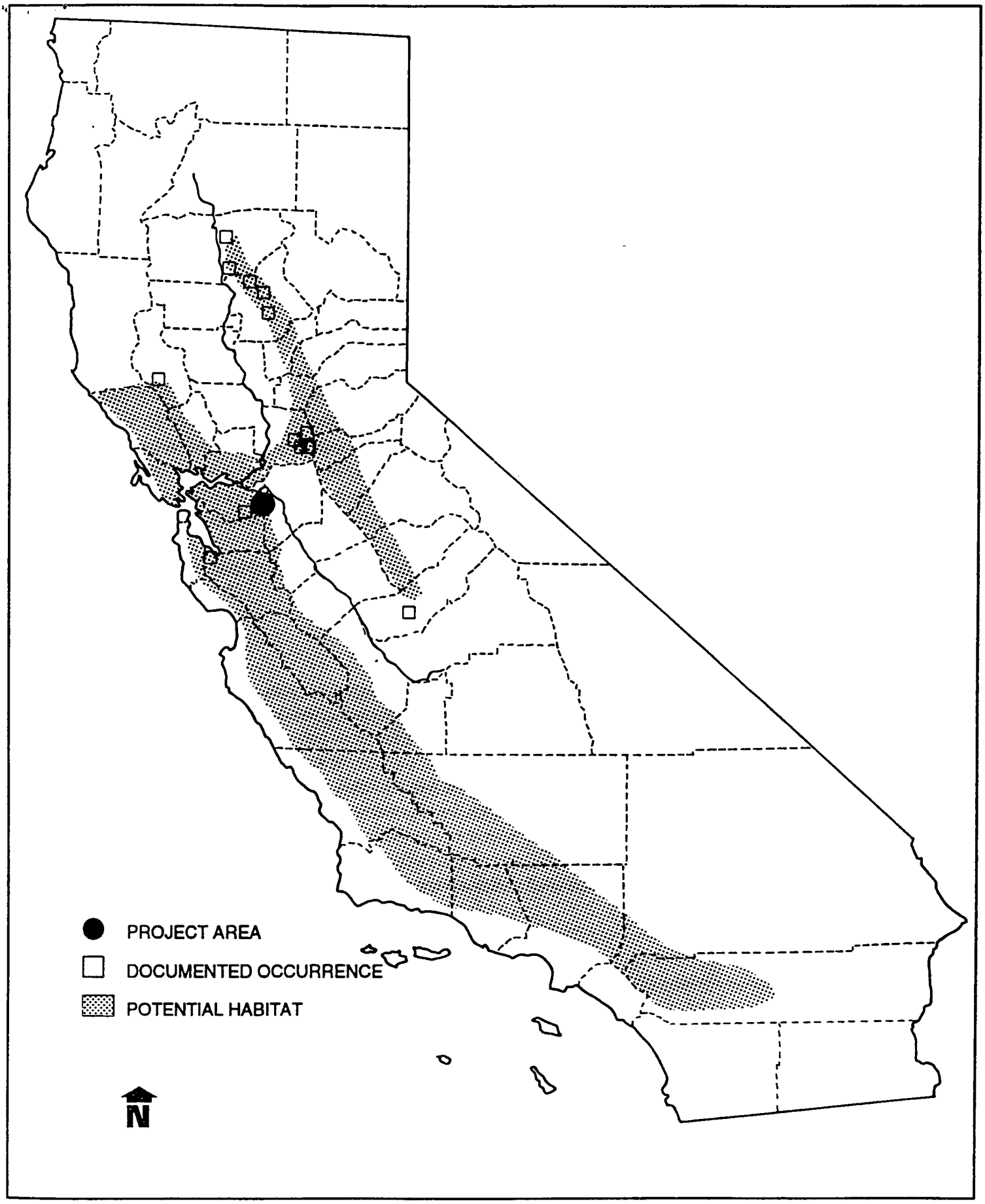
1. Most commonly, Californian linderiella was found in pools in grass-bottomed swales in old alluvial soils underlain by hardpan, containing "clear through often tea-colored water" (Eng *et al.* 1990).
2. Less frequently, they were found in mud-bottomed pools with lightly turbid water.
3. Occasionally, they inhabited clear-water depression pools in sandstone or old lava flows.

Pool size varies widely from about 1 square meter to the 40-hectare [99-acre] Boggs Lake (Eng *et al.* 1990). Water quality was characterized by very low alkalinity, total dissolved solids (TDS), conductivity, and chloride. As a result, waters were "poorly buffered," and pH values varied (both daily and seasonally) about a unit to either side of neutral. Californian linderiella "hatches best at around 10°C [50°F], a common mean temperature throughout its distribution" (Eng *et al.* 1990). Similarly, Eng *et al.* (1990) postulate a limiting high temperature for adults, and report (from Patton 1984) that Californian linderiella disappeared from pools when mean air temperature exceeded 17-21°C (63-70°F).

Although the term "fairy shrimp" is more correctly applied to *Branchinecta* spp., the life cycle is similar for both species. Fairy shrimp typically complete their life cycle in approximately two months (Eng pers. comm.), but depending upon species and temperature, this period may range from 2-12 weeks (Mizutani *et al.* 1991). "Nearly all fairy shrimp feed upon algae, bacteria, protozoa, rotifers, and bits of detritus" (USFWS 1992b). Eggs are either dropped at the bottom of the pond, or remain attached to the female until she dies and sinks. The thick-shelled eggs are very tolerant of adverse conditions (i.e., heat, cold, and prolonged desiccation), and hatch when the vernal swale/pool fills again with runoff (USFWS 1992b). Some eggs have been known to last as long as 15 years (Balfour pers. comm.).

Critical Habitat

No critical habitat has been designated for Californian linderiella.



Distribution of the Californian Linderiella in California

Reasons for Decline

Although Californian linderiella has been known since 1923, population estimates are inadequate to document a "decline." However, a consideration of habitat requirements and the currently documented range indicate that "pools presumably supporting *L. occidentalis* were once widespread in the Central Valley" (Eng *et al.* 1990), and in the margins of the bordering mountain ranges. Much suitable habitat has been lost to agricultural and other development activities since the 1800s, thus contributing to a probable corresponding decline of the species. Holland (1978) estimates that, at the time Europeans arrived in California, there were 6 million acres of vernal pools in the Central Valley; by 1970, approximately 5.4 million acres (90 percent) had been destroyed (Holland 1978, 1988). Holland (1988) estimates that vernal pool habitat loss continues at a rate of 2 to 3 percent per year.

In general terms, the restriction of the species to small, widely scattered locations renders individual populations extremely vulnerable to localized disturbance. Recent work by Mizutani *et al.* (1991) suggests that the longhorn fairy shrimp (*Branchinecta longiantenna*) is sensitive to relatively low concentrations (i.e., 1 part per million) of cadmium and zinc, though somewhat less sensitive to lead. Sensitivity to other heavy metals (e.g., selenium) is unknown; however, in areas where local geology/hydrology permit leaching into vernal pools (e.g., drainages downstream from mine tailings or major roadways) this may represent a threat which extends to other species, including Californian linderiella.

Potential for Occurrence in the PSA

The Delta lies well within the documented range of the species, and a recent report (Jones & Stokes Associates 1992) indicates Californian linderiella from two proximal locations, one within the Kellogg Creek watershed. While incongruous soil origin argues against the possibility that Californian linderiella would occur on any of the Delta islands (island soils are derived from peat accumulations and lack "hardpan" clay), it is possible that this species may occupy vernal swales and pools in the western portion of the ISDP area. Fairy shrimp have recently been located in fields that have been cultivated for several years (Balfour pers. comm.), and they have been collected from elevations as low as 10 feet (Eng *et al.* 1990). This represents a potential conflict with Alternative 6 (Byron Tract Forebay Configuration), which would inundate some 2,900 acres of former grassland.

Proposed Survey Methodology

Field surveys will focus on Byron Tract to determine whether ephemeral pools and swales are present. Preliminary survey efforts will include a review of soil surveys, topographic data, and recent aerial photography (shot during the rainy season), to identify remaining vernal swales and pools.

Field surveys to sample for Californian linderiella will be conducted by experienced personnel in areas identified during preliminary surveys, and in irrigation ditches and drainage channels. To ensure adequate coverage, field surveys should consist of one survey per pool per month during January, February, and March. However, adults of Californian linderiella have been observed from late October to early May (USFWS 1992b). Contingent upon weather conditions and approval from the USFWS it may be feasible to conduct field surveys during this extended period. Fairy shrimp, including Californian linderiella, collected during such surveys will be identified by qualified individuals.

Alternatively, off-season (i.e., dry season) soil sampling, combined with laboratory incubation of fairy shrimp eggs has recently proven successful (Eng pers. comm., Eng *et al.* 1990). Laboratory protocol is better-established for Californian linderiella than for more recently described species. However, the field selection of representative soil samples may remain problematic and a negative result should be interpreted as "inconclusive."

Ciervo Aegialian Scarab Beetle

Status

The Ciervo aegialian scarab beetle (*Aegialia* [*Aegialia*] *concinna*) is classified by the USFWS as a Category 2 candidate species.

Distribution

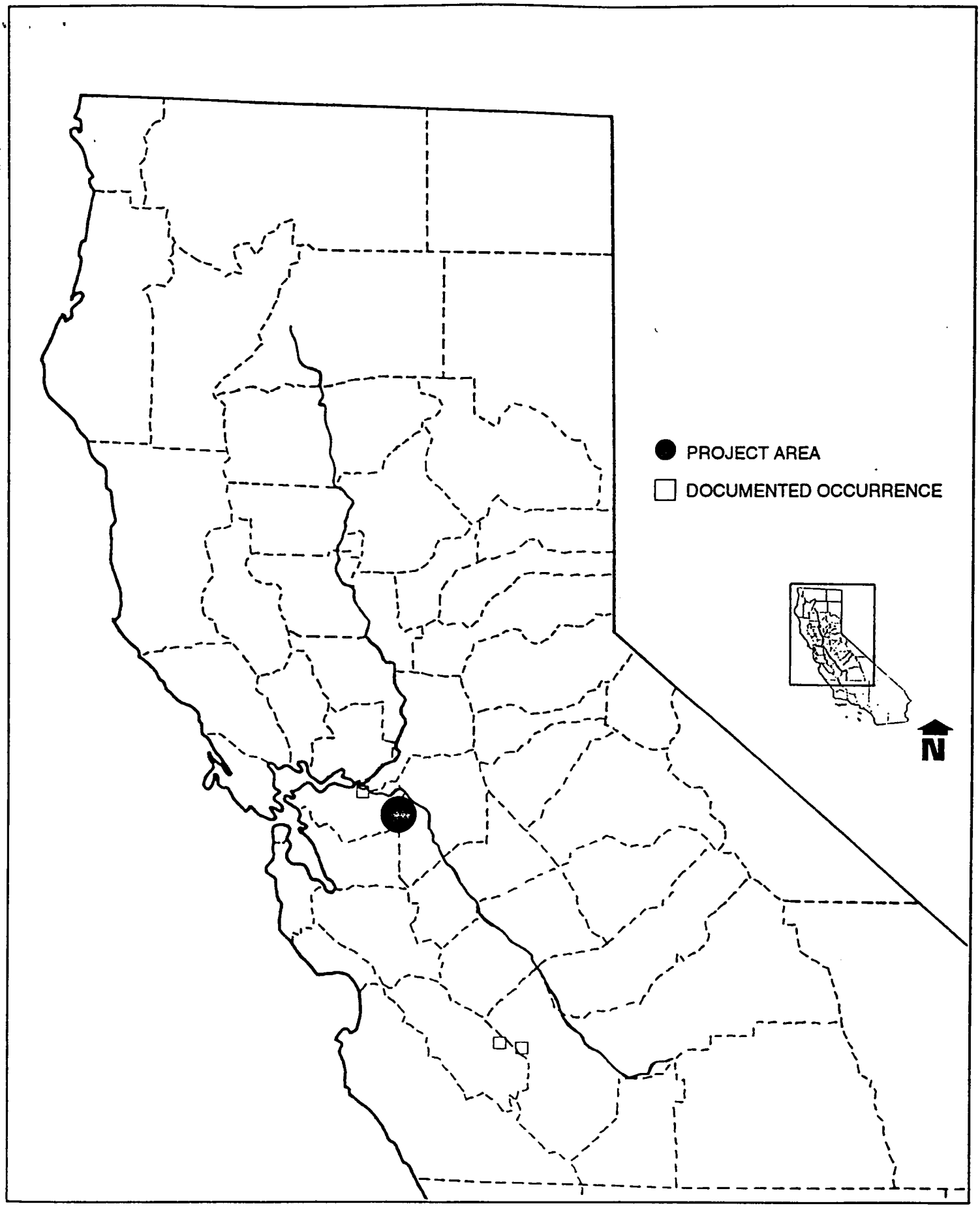
The NDDB (1992) provides only a single distribution record for the Ciervo aegialian scarab beetle: T16S, R13E, Section 15, Monocline Ridge USGS 7 1/2 minute topographic quadrangle, Fresno County, elevation 920 feet. Since the type material was described by Gordon and Cartwright (1977), more collections have been reported (Gordon and Cartwright 1988). These include:

1. "California: Contra Costa Co., Antioch;" ...
2. California: "Fresno Co., Monocline Ridge;" and ...
3. California: "San Benito Co., Panoche Road."

This description is inadequate to distinguish "Fresno County, Monocline Ridge" from the type-locality. Hence, it is undetermined whether this record constitutes subsequent collections from the type-locality, or collections from another location nearby. Due to this confusion, "Fresno Co., Monocline Ridge" is herein assumed to represent the type-locality, and the new record will be treated as a recent collection from the type-locality. Thus, the Ciervo aegialian scarab beetle is known from only three locations; these are plotted on the distribution map.

Habitat Requirements

Little has been reported regarding the specific habitat/life cycle requirements for the Ciervo aegialian scarab beetle. In general, *Aegialia* "are psammophiles found on coastal dune systems, inland dunes, or wherever the substrate is essentially sandy" (Gordon and Cartwright 1988). This may include riverine sand deposits (Rust and Hanks 1982, Gordon and Cartwright 1988). Members of the subgenus *Aegialia* are more strictly associated with dune habitats than are other subgenera (Gordon and Cartwright 1988). *Aegialia* spp. (both adults and larvae) feed upon vegetative detritus (Rust and Hanks 1982, Gordon and Cartwright 1988), which normally accumulates under the canopy of various dune-inhabiting plants.



Distribution of the Ciervo Aegialian Scarab Beetle in California

From work in Nevada aeolian (wind-deposited) sand dunes, Rust and Hanks (1982) provided more detail regarding the biology of *Aegialia hardyi*, a flightless member of the subgenus *Aegialia*. Both adults and larvae of *A. hardyi* were taken from "sand removed from the bases of emergent-shrub and grass vegetation on the dunes," where they were reported in extremely "clumped" distribution. None were found in open sand. Adults and larvae were always found in moist sand and were never observed on the surface. Pitfall trapping captured only one adult. While specific associations are reported for *A. hardyi*, which preferred *Tetradymia tetrameres, Chrysothamnus viscidiflorus*, and *Eriogonum kearneyi*, microhabitat preferences for the Ciervo aegialian scarab beetle have not been similarly reported. The presence of the Ciervo aegialian scarab beetle at the Antioch Dunes (Contra Costa County), which are believed to represent the northern extension of a once large inland desert (USFWS 1980), may indicate similar desert affinities. However, the Monocline Ridge and Panoche Road localities (Fresno and San Benito counties, respectively) are believed to represent the remains of sand beaches which bordered prehistoric intrusions of the Pacific Ocean into what is now the San Joaquin Valley (Doyen 1976).

Critical Habitat

No critical habitat has been established for the Ciervo aegialian scarab beetle, however, one locality from which this species is known (i.e., the Antioch Dunes), is legally protected as critical habitat for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). In 1980, approximately 55 acres of the Antioch Dune system were acquired by the USFWS (USFWS 1980), and were subsequently placed in the San Francisco Bay National Wildlife Refuge Complex (WWF 1990). These lands, along with additional acquisitions, now comprise the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

Work with the Ciervo aegialian scarab beetle, only recently discovered (Gordon and Cartwright 1977), is scant, and population estimates are inadequate to document a decline. In general, suitable habitat for dune-inhabiting species in the San Joaquin Valley is limited and greatly fragmented. Historically, habitat destruction due to agricultural development, flood control, and water management have reduced the availability of suitable habitat. In addition, Gordon and Cartwright (1977) reported that "many of the dune systems" ... "are under pressure from recreational and commercial interests, and the resulting use of the dunes often destroys them from the natural history point of view."

Potential for Occurrence in the PSA

Due to the lack of suitable relict dune habitat, the potential for occurrence of the Ciervo aegialian scarab beetle in the ISDP area is considered unlikely. In general, the level of disturbance in the Delta is believed to preclude the possibility of suitable remaining habitat. Despite extensive work in the area, no dune habitat has been reported, and preliminary reconnaissance surveys have identified none.

However, the lack of specific preferred plant associations, and the presence of the Ciervo aegialian scarab beetle in both relict coastal (San Benito and Fresno counties) and desert (Contra Costa County) dunes, suggest that it also may have colonized other sand dune deposits. Rust and Hanks (1982) reported that *A. hardyi* may be found in "wet sand, as along streams." Thus, it is possible that riverine deposits may have been colonized. In addition, Andrews (pers. comm.) has stated that it is "not impossible" that Ciervo aegialian scarab beetles may inhabit the sandy mush country of the San Joaquin Valley.

Proposed Survey Methodology

Although, its occurrence in the ISDP area is considered unlikely, given the species' ability to use dune formations of various origins, surveys will focus upon the identification of suitable habitat during field surveys for other sensitive species. It is important to note that such habitat should constitute true dune (including riverine deposits) with established populations of emergent-shrub and grass vegetation, and not recently formed and/or disturbed sandy habitat (i.e., dredge spoils storage/disposal areas).

Should true suitable dune be identified, follow-up surveys will be conducted during the known adult activity season. This is somewhat problematic. While Rust and Hanks (1982) report a winter-only (October-May) activity season for *A. hardyi* (attributed to hot dry summers, similar to conditions in California's Central Valley), adults of other members of the genus (*A. blanchardi, A lacustris, A. latispina*, and *A. conferta*) have been found year round with larvae appearing in early summer (Jerath and Ritcher 1959, and Jerath 1960 *in* Rust and Hanks 1982). The only published date of recorded collection (for the holotype) of the Ciervo aegialian scarab beetle is November 27 (Gordon and Cartwright 1977). In order to guard against misinterpretation of a negative result, it is recommended that follow-up surveys be conducted during November.

Consistent with methods outlined by Rust and Hanks (1982) for *A. hardyi*, researchers will excavate around the stems of emergent shrub and grass vegetation (within the shadow of the canopy) to an estimated depth of 50 cm. Due to reportedly "extremely clumped" distribution of *A. hardyi*, such excavations will be undertaken in no less than three separate locations around the base, underneath the canopy of the vegetation.

Antioch Dunes Anthicid Beetle

Status

The Antioch Dunes anthicid beetle (*Anthicus antiochensis*) is classified by the USFWS as a Category 2 candidate species.

Distribution

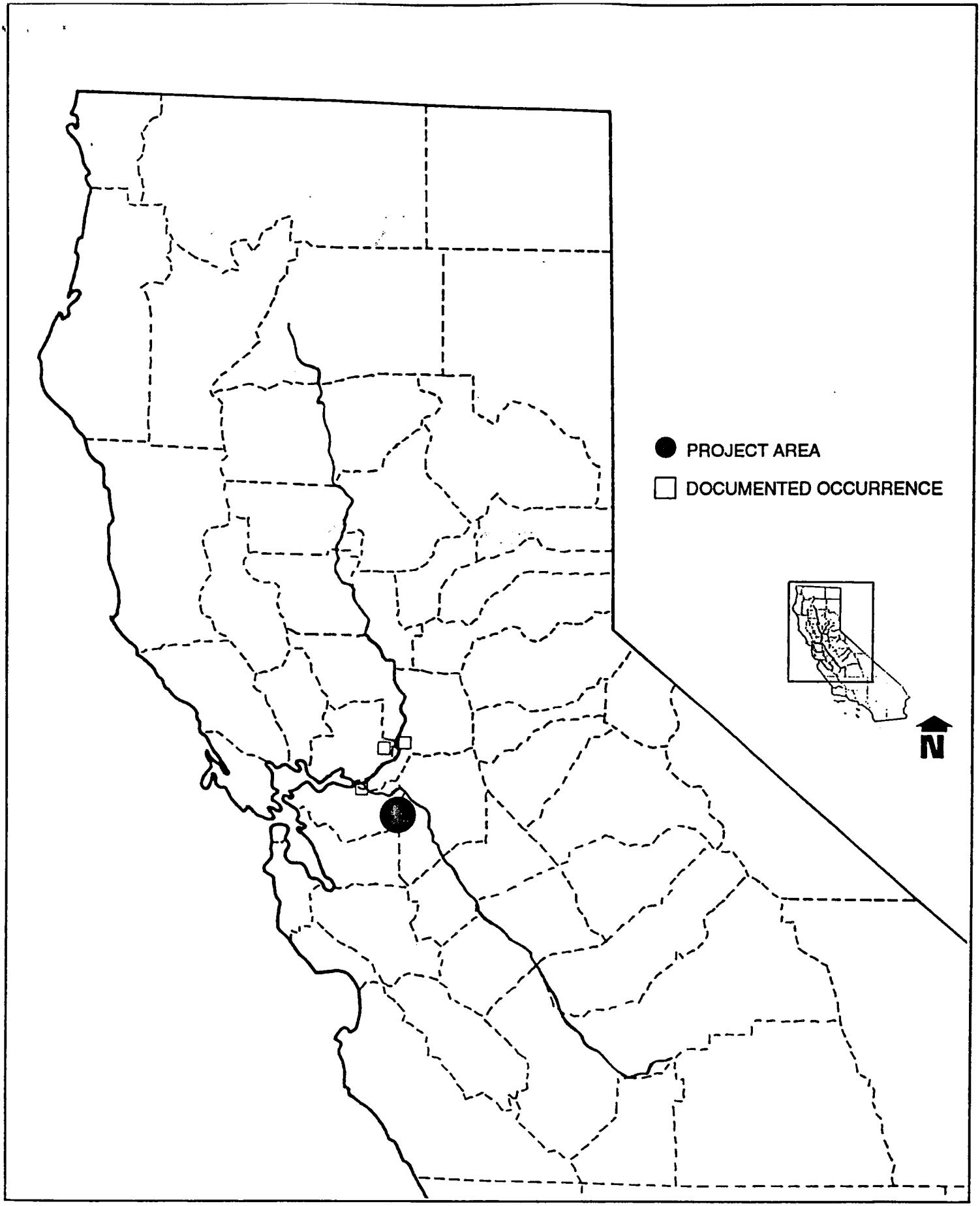
The NDDB (1992) reports only one general occurrence for the Antioch Dunes anthicid beetle during 1953 at the Antioch Dunes, Contra Costa County (its type-locality) (Werner 1975). Surveys conducted at this location during 1981-82 by Powell, and during 1983-84 by Hagen yielded no individuals (Hagen 1986). Hagen (1986) concluded that the species no longer exists at Antioch. However, he identified the Antioch Dunes anthicid beetle from sandy areas at the west end of Grand Island (Sacramento County) during 1983-86, where Chandler found none in 1981 (Hagen 1986). In addition, he found the Antioch Dunes anthicid beetle in sandy areas within and adjacent to Sandy Beach County Park, near Rio Vista (Solano County) during the same period (Hagen 1986). Other Delta locales surveyed by Hagen (1986) included Cliff House State Park and Brannan Island State Park (Sacramento County). No Antioch Dunes anthicid beetles were found at either location.

Surveys outside of the Delta, conducted along the Sacramento River (Tehama, Butte, and Yolo counties), Putah Creek (Yolo County), and the San Joaquin River (Fresno County), also yielded negative results. Hagen (1986) concluded that the species is currently restricted to sandy areas at the west end of Grand Island (Sacramento County), and at/near Rio Vista (Solano County). The distribution map defines the range for the Antioch Dunes anthicid beetle from these current and historical distribution records.

Habitat Requirements

The Antioch Dunes anthicid beetle occupies accumulations of loose sand, where larvae probably feed upon vegetable detritus (as reported for other anthicid larvae) (Borror and White 1970, Kitayama 1982). Hagen (1986) theorizes that:

> "*Loose sands formed as dunes, bars or alluvial fans in riparian locations probably were the pristine habitat ... The loose sand ... apparently provides a [substrate] from which wind-deposited food is gleaned, and the shifting sands in the form of dunes and bars provide 'islands' which serve to protect the anthicids from terrestrial predators ...*"



Distribution of the Antioch Dunes Anthicid Beetle in California

The need for "loose" sand is apparently critical. Hagen (1986) describes the Antioch Dunes as "becoming stabilized" with "relatively little loose sand present." He implies that the current stability of the dunes at Antioch is the reason for apparent extirpation of the Antioch Dunes anthicid beetle.

Critical Habitat

No critical habitat has been established for this species. However, the type-locality (i.e., the Antioch Dunes), from which it is now believed to have been extirpated, is legally protected as critical habitat for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). In 1980, approximately 55 acres of the Antioch Dune system were acquired by the USFWS (USFWS 1980), and were subsequently placed in the San Francisco Bay National Wildlife Refuge Complex (WWF 1990). These lands, along with additional acquisitions, now comprise the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

Population estimates are inadequate to document a decline of the Antioch Dunes anthicid beetle. However, its apparent extirpation from the Antioch Dunes (its type-locality) and one of only three locales from which it has been reported, represents a significant setback for the species.

Historically, agricultural and economic development activities (e.g., land reclamation, flood control, water management, and sand mining) have been identified as the causes for wide-scale habitat destruction. In general, larger dune systems are continually shifted and reformed by winds, erosion, and new sand deposition. Thus, they are constantly renewing suitable microhabitats. Once limited in size and isolated from these causative agents, new dune formation ceases. As the existing dunes are stabilized by encroaching vegetation, new unstabilized formations no longer replace them. In addition, predation by the introduced Argentine ant (*Iridomyrmex humilis*) is considered to represent a significant threat to the species (Hagen 1986). Paradoxically, human disturbance (e.g., dredge spoils disposal and recreational use by off-road vehicles) is now considered beneficial in providing unstabilized sand habitat, critical to the species' continued survival (Hagen 1986).

Potential for Occurrence in the PSA

Due to its historical distribution at the Antioch Dunes, and its current distribution at Grand Island and Rio Vista, the Antioch Dunes anthicid beetle may exist in unstabilized and/or disturbed sandy habitat within the Delta, and more specifically, within the ISDP area.

Proposed Survey Methodology

Reconnaissance surveys will be conducted within the ISDP area, focusing on Byron Tract, to determine whether "significant" areas of disturbed and/or unstabilized sandy habitat are present. Reconnaissance surveys will be conducted in association with survey efforts for other sensitive species. Should suitable habitat be located, follow-up survey methods could include pitfall trapping and/or field observation, as described by Hagen (1986). Follow-up surveys should be conducted during the documented adult activity season (discussed below) by personnel with field experience regarding morphology and behavior.

In general, adults are believed to overwinter in sandy areas. Hagen (1986) reports that adults of this species are known to be active in November and March. They mate, oviposit, and produce larvae in the early spring, but a mating pair has been trapped as late as May 5 (Hagen 1986). Most larvae have been obtained during April and May, but some have been found as late as September 15 (perhaps suggesting a second generation) (Hagen 1986). New adults reportedly emerge during the early summer (Hagen 1986).

A preliminary review of Hagen's data indicates peaks in adult activity during April, May, July, and September through November, thus, lending credence to the possibility of multiple generations per year. Further, other anthicids are reported to produce multiple generations per year (Hamad and Aly 1980-81). It is believed that April and May represent the most favorable time for follow-up survey efforts for the following reasons: 1) data indicate a peak in adult activity in April and May; 2) most larvae have been obtained in April and May, and 3) the production of a second generation of the Antioch Dunes anthicid beetle in the fall has not yet been verified. Should this window be inopportune, another effort may be made from September through November. Adults of the Antioch Dunes anthicid beetle are active at night (Hagen pers. comm.), and there is significant diel periodicity, seasonality, and correlation with major weather factors reported for adult flight activity of other anthicids (Hamad and Aly 1980-81).

Sacramento Anthicid Beetle

Status

The Sacramento anthicid beetle (*Anthicus sacramento*) is classified by the USFWS as a Category 2 candidate species. In 1978, it was proposed as threatened with critical habitat (USFWS 1978), but the rule was not adopted.

Distribution

The NDDB (1992) reports only two specific occurrences for the Sacramento anthicid beetle:

1. the west end of Grand Island (Sacramento County), its type-locality, from which Wasbauer collected it in 1966, and Doyen, Opler, and Powell, again collected it in 1975 (Chandler 1978a); and
2. the "sand dune area immediately south of Rio Vista" (Solano County), from which Chandler collected it in 1974.

In addition to the NDDB's second record, Chandler (1978a) also reports a 1974 collection by Doyen and Opler from a locale "2 mi SW Rio Vista." Chandler (1978b) surveyed these areas during the fall of 1978, but did not find Sacramento anthicid beetles. With the exception of "2 mi SW Rio Vista" (the status of which is unknown), Hagen worked these areas during 1983-86, and collected Sacramento anthicid beetles from Grand Island and Rio Vista (Hagen 1986). In addition, he sampled three other Delta locations: 1) Cliff House State Park (Sacramento County), 2) Brannan Island State Park (Sacramento County), and 3) the Antioch Dunes (Contra Costa County). The Sacramento anthicid beetle was collected at Cliff House State Park (Sacramento County), but not at either of the other locations. Cumulatively, the Sacramento anthicid beetle is known from four locations in the Delta.

Outside of the Delta, recent surveys were conducted along the Sacramento River (Tehama, Butte, and Yolo counties), Putah Creek (Yolo County), and the San Joaquin River (Fresno County). During 1984-85, these surveys yielded Sacramento anthicid beetles from "sand dunes under a bridge on Ord Ferry Road, which crosses the Sacramento River 2 miles east of Ord" (Butte/Glenn counties) (Hagen 1986). Thus, the Sacramento anthicid beetle was now known from a total of five locales:

1. the west end of Grand Island (Sacramento County),
2. Rio Vista (Solano County),
3. 2 mi SW Rio Vista (Solano County),
4. Cliff House State Park (Sacramento County), and
5. 2 miles east of Ord (Butte/Glenn counties).

The distribution map defines the range for the Sacramento anthicid beetle from these current and historical distribution records.

Habitat Requirements

The Sacramento anthicid beetle occupies accumulations of loose sand, where larvae probably feed upon vegetable detritus (as reported for other anthicid larvae) (Borror and White 1970, Kitayama 1982). Hagen (1986) theorizes that:

> *"Loose sands formed as dunes, bars or alluvial fans in riparian locations probably were the pristine habitat ... The loose sand ... apparently provides a [substrate] from which wind-deposited food is gleaned, and the shifting sands in the form of dunes and bars provide 'islands' which serve to protect the anthicids from terrestrial predators ..."*

The need for "loose" sand is apparently critical. Hagen (1986) implies that the current stability of the Antioch Dunes has contributed to the apparent extirpation of the related species, the Antioch Dunes anthicid beetle (*Anthicus antiochensis*), from the Antioch Dunes.

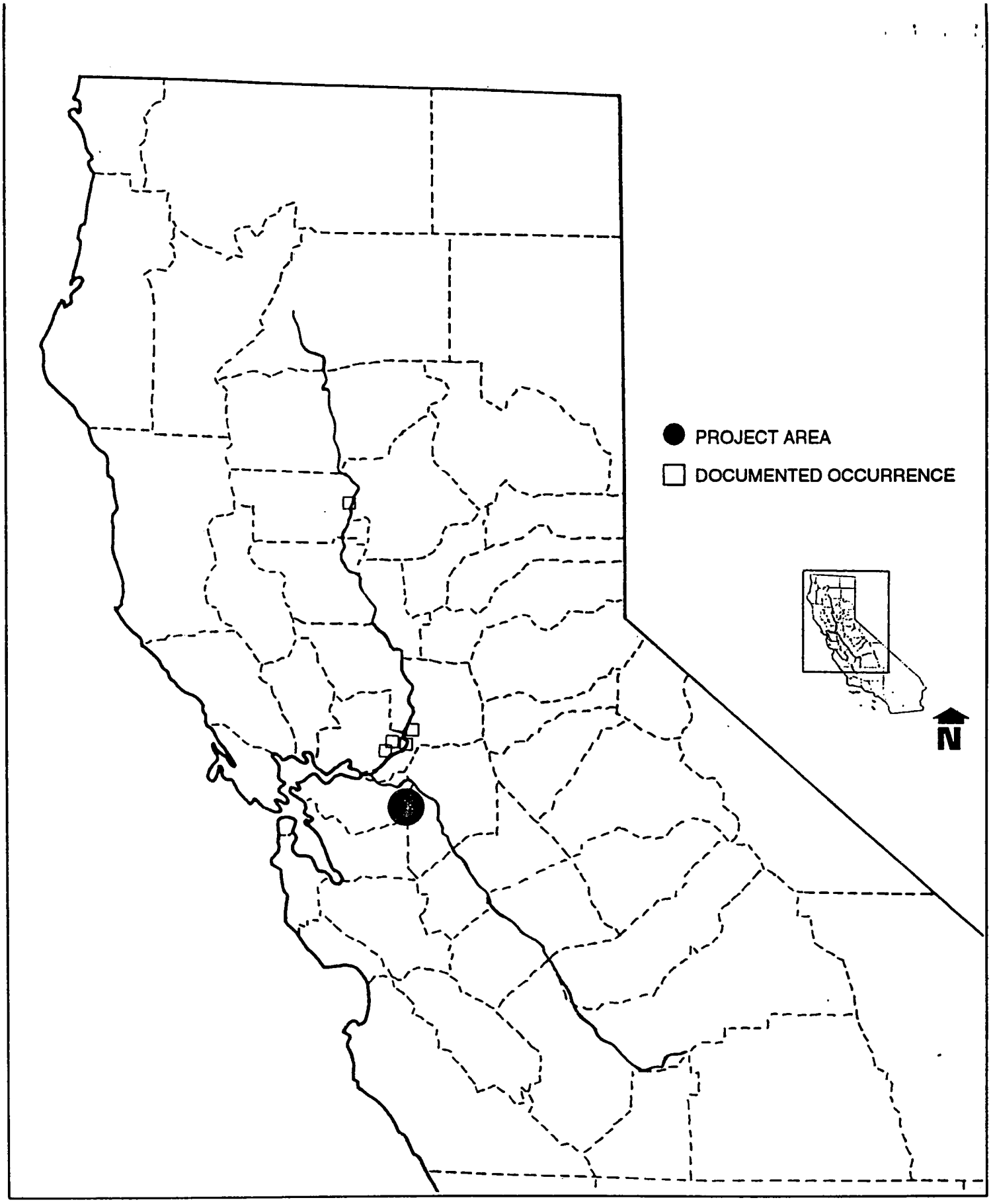
Critical Habitat

No critical habitat has been defined for the Sacramento anthicid beetle. Critical habitat, consisting of the western end of Grand Island (Sacramento County) and the area south-southwest of Rio Vista (Solano County), was proposed in 1978 (USFWS 1978), but was not established. The legal description of the proposed zone in Solano County (USFWS 1978) matches well with the site described in the literature as "2 mi SW Rio Vista," and it is presumed that these descriptions represent the same location.

Reasons for Decline

Population estimates are inadequate to document a decline of the Sacramento anthicid beetle. It should be noted that recent work (Hagen 1986) has confirmed the presence of the species in all reported historical locations (except "2 mi SW Rio Vista," which was unsampled), and has identified two new locations (one in the Delta, and another well-removed upstream).

Historically, agricultural and economic development activities (e.g., land reclamation, flood control, water management, and sand mining) have been attributed the blame for wide-scale habitat destruction. In general, larger dune systems are continually shifted and reformed by winds, erosion, and new sand deposition. Thus, they are constantly renewing suitable microhabitats. Once limited in size and isolated from these causative agents, new dune



Distribution of the Sacramento Anthicid Beetle in California

formation ceases. As the existing dunes are stabilized by encroaching vegetation, new unstabilized formations no longer replace them. In addition, predation by the introduced Argentine ant (*Iridomyrmex humilis*) is considered to represent a significant threat to the species (Hagen 1986). Paradoxically, human disturbance (e.g., dredge spoils disposal and recreational use by off-road vehicles) is now considered beneficial in providing unstabilized sandy habitat, critical to the species' continued survival (Hagen 1986).

Potential for Occurrence in the PSA

Due to its historical and current distribution at four locations within the Delta, it is considered possible that the Sacramento anthicid beetle exists in unstabilized and/or disturbed sandy habitat within the ISDP area.

Proposed Survey Methodology

Reconnaissance surveys will be conducted to determine whether "significant" areas of disturbed and/or unstabilized sandy habitat exist in the ISDP area. Surveys will focus on Byron Tract and will be conducted as part of other sensitive species surveys. Should suitable habitat be located, follow-up sampling methods could include pitfall trapping and/or field observation, as described by Hagen (1986). Follow-up surveys should be conducted during the documented adult activity season (discussed below) by personnel with field experience regarding morphology and behavior. Specimens collected should be identified by qualified personnel.

In general, adults are believed to overwinter in sandy areas. Sacramento anthicid beetle adults are known to be active in November and March (Chandler 1978a, Hagen 1986). They mate, oviposit, and produce larvae in the early spring; new adults emerge during early summer (Hagen 1986). Other workers (i.e., Chandler, Doyen, Opler, and Powell) have reported adult collections in July and August (Chandler 1978a). A preliminary review of Hagen's data (1986) indicates adult activity peaks in April and May, and again, in July through September. However, no late summer-fall collections of larvae are reported. Instead, all larvae have been obtained during April and May (Hagen 1986). Therefore, the production of more than one generation per year is speculative. Chandler (1978b) recommends that survey efforts are best undertaken in June and July. Due to this, and the magnitude of the July-September adult activity peak reported by Hagen (1986), it is believed that July through September represents the most favorable time for follow-up survey efforts for this species. Sacramento anthicid beetle adults are active at night (Hagen pers. comm.), and there is significant diel periodicity, seasonality, and correlation with major weather factors reported for adult flight activity of other anthicids (Hamad and Aly 1980-81).

Sacramento Valley Tiger Beetle

Status

The Sacramento Valley tiger beetle (*Cicindela hirticollis abrupta*) is classified by the USFWS as a Category 2 candidate species.

Distribution

The NDDB (1992) provides no distribution data for the Sacramento Valley tiger beetle. A careful compilation of data presented by Graves (1988a,b, pers. comm.) yielded a total of eight distribution records:

1. "Sacramento, California" [Sacramento County] (i.e., the type-locality, from which it was originally described as *Cicindela gravida abrupta* by Casey in 1913) (Graves 1988b);
2. "Davis" [Yolo County], in 1934, (no additional data) (Graves 1988a);
3. "Feather River" [Sutter County], in 1942, by N.L. Rumpp (Graves 1988a);
4. "Sacramento County", in 1950, by J.H. Robinson (Graves 1988a, pers. comm.).
5. "Nicolaus" [Sutter County], in 1970, by W.D. Sumlin (Graves 1988a);
6. "Sutter County", in 1974, by F.G. Andrews (Graves 1988a);
7. "Sutter County", in 1984, by D. Brzoska (Graves 1988a);
8. "Highway 99 at Feather River" [Sutter County], (no additional data) (Graves pers. comm.).

These records are the result of Graves' comprehensive survey of museum specimens, which are often inadequately labelled to determine precise locations or dates. The last record (#8) may represent a duplication of any one of records #3-7, or may represent an independent observation. Cumulatively, these data indicate a historical distribution on the Feather River, the Sacramento River (presumed, due to the Feather being a tributary), and Putah Creek (presumed, from the "Davis" record).

Graves (1988b) postulated a potential intergradation with Pacific coast populations of *C. hirticollis gravida* based upon sexual dimorphism regarding female elytral shape common to both subspecies. He hypothesized that "*C. h. abrupta* arose as an offshoot of *C. h. gravida* which invaded the Sacramento Valley from the coast and became isolated there." If an intergrade has occurred, additional collections reported by Graves (1988a) from Oakland (Alameda County, no date, by Wickham), San Francisco (San Francisco County, 1907, no additional data), and Sonoma County (1907, by E.B. Andrews) may deserve further attention.

An interpretation of the documented distribution of the Sacramento Valley tiger beetle is depicted on the distribution map. Where possible, discrete points are mapped; where data are inadequate to distinguish discrete locations, entire reaches of the rivers are shaded. Finally, the potential intergrade zone has been represented (after Graves 1988b, Figure 6).

Habitat Requirements

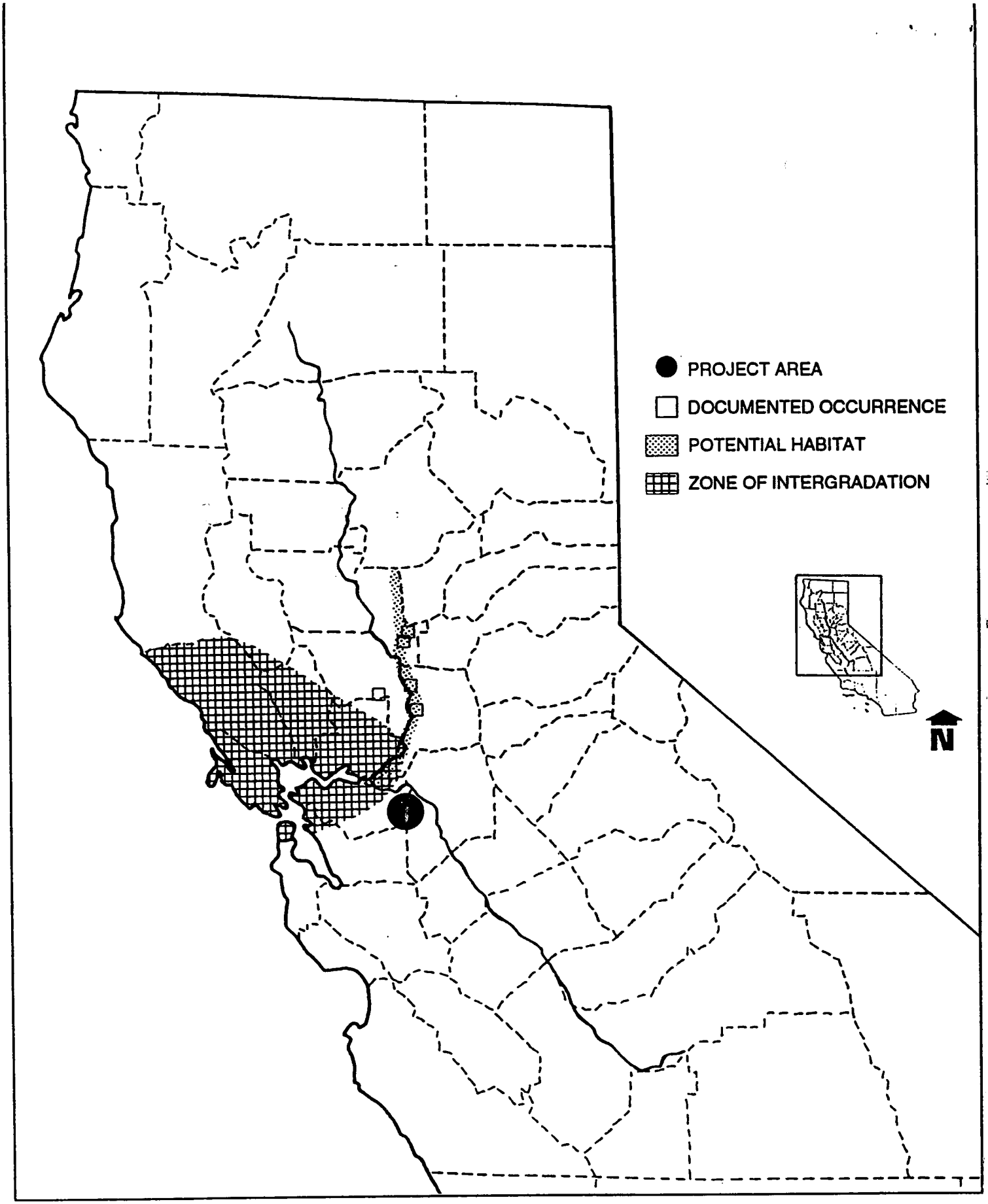
Little is reported on the specific biology or habitat requirements of the Sacramento Valley tiger beetle. Graves (1988b) reported that *C. hirticollis* is associated with shoreline and riverine sand deposits, where larvae inhabit burrows in the sand that remain constantly moist near the bottom. Nagano (pers. comm.) describes occupied sands as "light-colored." Adults run rapidly in open sandy situations near the larval habitat, and are reported to not stray far from it (Graves 1988b).

Pearson (1988) provided a comprehensive overview of the biology of tiger beetles (*Cicindelidae*). Summarized from Pearson (1988): Tiger beetles are known to inhabit a variety of habitats, where adults and larvae prey upon other insects. Eggs are laid within the substrate, and in 9-29 days, eclose to the first instar larvae. All known larvae construct tunnels from 15-200 cm (6-80 inches) deep, usually perpendicular to the surface, where they wait to ambush passing prey. Burrows constructed by sand-dwelling species (such as the Sacramento Valley tiger beetle) often have a funnel or pit at the entrance.

There are three larval instars prior to pupation. The first lasts 1-3 weeks; the second, 1-2 months; and the third, several months to several years. The entire process may take 1-4 years, but 2 years is the most common duration. All stages live within the burrow, which is enlarged following each eclosure. Before pupation, the third instar larvae will plug the tunnel entrance and excavate a pupal cell. Approximately three days after pupation, adults emerge.

Adults also prey upon a variety of arthropods, but scavenging is not unusual. Several species typical of pond edges, mudflats, and ocean beaches use their mandible to probe into the wet soil for buried prey. They are capable of flight. Graves (1988b) reported that *Cicindela* are strong flyers for short distances and many species are reportedly attracted to lights.

Larval tiger beetles plug their burrow entrances and become inactive during hot, dry periods; larvae of riverine species routinely survive inundation in closed burrows (although erosion and burrow "washout" remain mortality factors). Even adults of some species will pass the rainy season in burrows. In extreme cases of desiccation or flooding, they will leave the burrow and relocate.



Distribution of the Sacramento Valley Tiger Beetle in California

Critical Habitat

No critical habitat has been established for the Sacramento Valley tiger beetle.

Reasons for Decline

Although the Sacramento Valley tiger beetle has been known for some time, population estimates are inadequate to document a "decline." A consideration of documented historical distribution, habitat requirements, and Graves' (1988b) hypothesis regarding intergradation with *C. h. gravida*, suggest that the species may have once been rather commonly distributed at sandbars and sandy shores within the Delta, upstream in various tributaries of the Sacramento River, and into the foothills of bordering mountain ranges. It is not reported from southern tributaries in the San Joaquin Valley where somewhat higher temperatures may have created an effective barrier to its dispersal.

Clearly, channelization of these rivers for flood control, water management, and land reclamation have played a significant role in reducing available habitat, providing barriers to dispersal, and effectively isolating individual populations. Pearson (1988) reported that the two most important limiting resources for *Cicindelidae* are the availability of oviposition sites and food. Graves (1988b) reported that, due to its specific habitat requirements, *C. hirticollis* is separated into many smaller populations that may be more or less isolated from one another geographically and genetically.

In general terms, the restriction of the species to small, widely scattered locations renders individual populations vulnerable to localized disturbance. Graves (1988b) believed that the Sacramento Valley tiger beetle "may be greatly endangered because of agriculture, insecticides, and modification of its habitat by man."

Potential for Occurrence in the PSA

The documented distribution of the Sacramento Valley tiger beetle indicates that it may be affected by changing water levels in the lower Feather River. Measurements taken near Gridley indicate that water levels in the Feather River may increase from 1 to 1.5 feet in August; in September, water levels may decrease by as much as 2 to 2.5 feet (see Appendix III). Depending upon local topography and hydrology, changes in water levels may impact duration of inundation and habitat availability.

If intergrades with *C. h. gravida* do exist, they are likely distributed within the Delta region. Depending upon the presence of suitable habitat, Sacramento Valley tiger beetles could be found within the ISDP area.

Proposed Survey Methodology

Because of potential adverse impacts to the Sacramento Valley tiger beetle resulting from the ISDP field surveys are recommended. Preliminary survey efforts will be conducted to identify potential habitat within the Delta, and upstream along the lower Feather River. This will include a review of topographic data and aerial photography (if possible shot during mean surface elevation conditions) of the channels to identify significant sand deposits between the levees. These sites should be surveyed by qualified personnel during known activity seasons. This is somewhat problematic, as collection dates (more specific than years) are not reported for any of the distribution records for the Sacramento Valley tiger beetle.

According to Pearson (1988), two major seasonal cycles are reported for adult *Cicindelidae*. In tropical and many temperate zone species, activity is observed only in the warm, moist seasons. Other temperate zone species are active in the spring and fall, and the seasonal activity cycle may vary from unimodal to bimodal in different parts of the range of a single species. Most larvae show either unimodal summer or bimodal fall and spring activity, but they are generally active throughout more of the year than adults. For these reasons, each identified site should be surveyed at least twice before a negative result is accepted. Surveys should be conducted in either the spring and summer, or alternatively, in the summer and fall.

Observers may key upon the rapid, erratic movement (both on the ground and in flight) of adults, the funnels or pits, which may be evident at the entrances of larval burrows; and upon the distinct and obvious appearance of tiger beetles. Adults of the Sacramento Valley tiger beetle are reported as "dark blackish-brown" with distinctive elytral maculation (see Graves 1988b, Figs. 17 and 18). In general, more effort should be concentrated in the lower, wetter portions of sand deposits (Nagano pers. comm.). Should populations large enough to withstand destructive sampling be located (particularly within the potential intergradation zone), specimens should be collected to support taxonomic studies.

Antioch Cophuran Robber Fly

Status

The Antioch cophuran robber fly (*Cophura hurdi*) is classified by the USFWS as a Category 2 candidate species.

Distribution

The NDDB (1992) provides only a single general occurrence record for the Antioch cophuran robber fly, from Antioch (Contra Costa County). Powell (1981) provides the basis for this record. A review of Powell (1981) indicates the species is known only from Antioch, and was last collected there in 1939. Subsequently, Pritchard (1943) revised the genus. Despite having obtained specimens from various localities in southern California and at Lake Tahoe, Pritchard did not report the Antioch cophuran robber fly (or any other representatives from Antioch). According to Powell (1981), the species was described by Hull in 1960. However, in a subsequent comprehensive treatment of the *Asilidae*, Hull (1962) does not report the Antioch cophuran robber fly. Despite the cloudy record in the literature, the species is considered historically to have been endemic to Antioch (Powell 1981); this is represented on the distribution map. Despite recent work there by Powell (1981), it has not been observed.

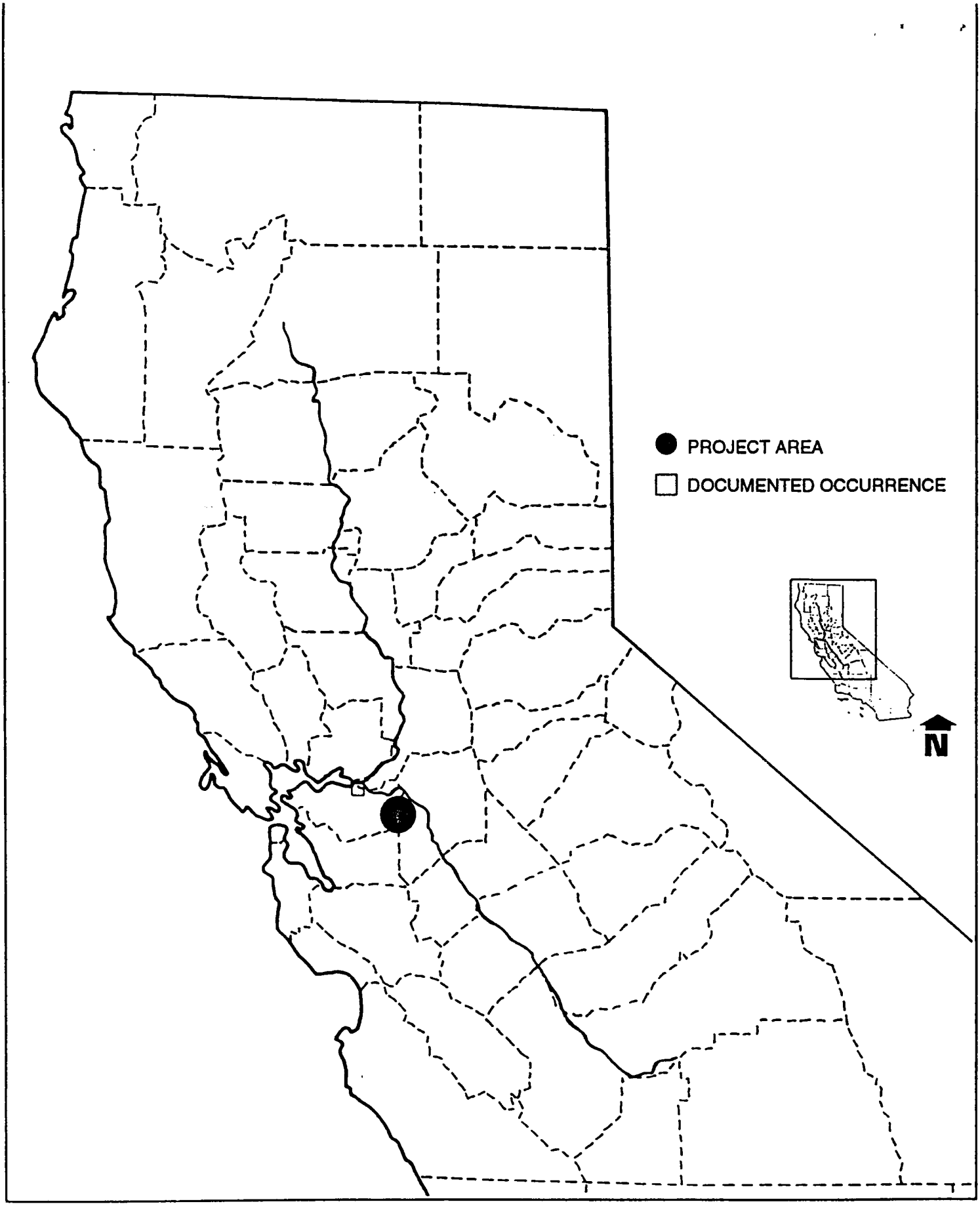
Habitat Requirements

Specific biology for the Antioch cophuran robber fly is not reported. Hull (1962) indicates that the majority of robber flies (Asilidae) "frequent dry and sandy areas." Further:

> *... even in desert or semidesert country the small drains of dry st[r]eam beds attract the greatest number, and sometimes the entire robber fly population of a region will be restricted to such places, which also have the maximum vegetation and the greatest population of insects upon which the flies feed.*

Adult asilids are said to be active several hours after sun up, and are occasionally active until sunset (Hull 1962). Most are active from 10 a.m. until 2 p.m., and are strongly affected by hot, bright sunshine (Hull 1962). The majority of adult *Cophura* spp. specimens examined by Pritchard (1943) were collected during June, July, and August.

Life spans range from a week to six months (Hull 1962). The larvae of many genera live in the soil, where they may feed upon either vegetable matter or other insect larvae (Hull 1962). The females of the tribe *Dasypogonini* are equipped with circlets of spines on the acanthophorites of the ovipositor to aid in oviposition of the eggs into the soil (Hull 1962).



Distribution of the Antioch Cophuran Robber Fly in California

Critical Habitat

No critical habitat has been defined for the Antioch cophuran robber fly. The reported type-locality (Antioch Dunes), is legally protected as critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). This area is now known as the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

Population estimates for the Antioch cophuran robber fly are inadequate to document a "decline." However, it apparently has been extirpated from Antioch (its only reported location). Powell (1981) noted that "several of the species described from Antioch are not known to have been observed there since the industrial build-up in the 1940s and early 1950s. In addition, from more recent work, he comments upon "a general decline in species diversity in some families with sand dune-based biologies, such as robber flies (*Asilidae*), ..."

Limiting factors for population size in asilids are not known (Hull 1962). Regarding adults, lack of available prey does not seem to be a factor; however, the larvae may find food scarcity a limiting factor (Hull 1962). Thus, the "general decline" of several insect species observed by Powell (1981) may have contributed to the apparent extirpation of the species at Antioch. The "general decline" has been attributed to habitat destruction during the industrialization of the area. In addition, given the potential extremely specific microhabitat associations reported for *Asilidae* by Hull (1962), it is possible that recent stabilization of the dunes has contributed to a lack of available habitat. Specific habitat preferences are unreported for the Antioch cophuran robber fly, but they may have been restricted to loose sand. Hagen (1986) described the Antioch Dunes as "becoming stabilized" with "relatively little loose sand present."

Potential for Occurrence in the PSA

The species is believed to be extinct based on the following items: 1) Despite recent work, the Antioch cophuran robber fly has not been reported since 1939; 2) It is specifically associated with dunes; and 3) It is likely to have even more restrictive microhabitat associations than reported for *Asilidae*, in general.

Proposed Survey Methodology

No specific surveys are proposed for this species; however, researchers will be looking for dune habitats, especially on Byron Tract, during surveys for other sensitive species. In

general, the level of disturbance in the Delta is believed to preclude the possibility of suitable habitat remaining. Despite extensive work in the area, this habitat type has not been reported and preliminary reconnaissance surveys have identified none. If dune habitat is found, it is important to note that such habitat should constitute true dune, and not recently formed and/or disturbed sandy habitat.

Curved-Foot Hygrotus Diving Beetle

Status

The curved-foot hygrotus diving beetle (*Hygrotus curvipes*) is classified by the USFWS as a Category 2 candidate species.

Distribution

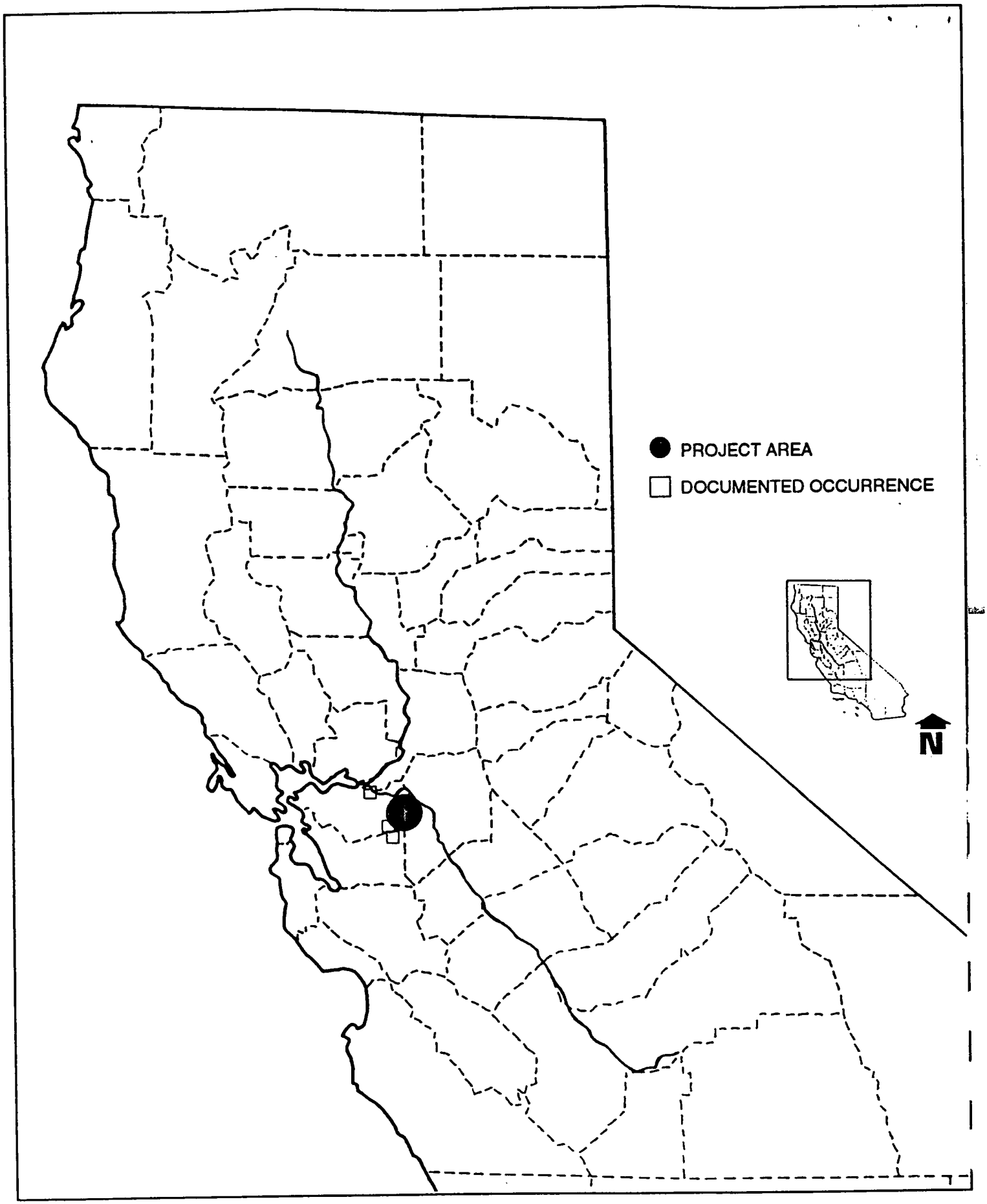
The NDDB (1992) provides only one record, "Oakley, 5 mi E of Antioch," from which it was reported as new species (*Coelambus curvipes*) by Leech (1938) from a collection made on September 5, 1936. The curved-foot hygrotus diving beetle was again collected from the type-locality by Van Dyke on August 21, 1938 (Leech 1966). Anderson (1983) confirmed this limited distribution. Thus, until very recently, the species was known only from its type-locality. However, Jones & Stokes Associates (1992) report that surveys conducted by Hafernik in 1988 and 1989 identified the curved-foot hygrotus diving beetle from 41 of 93 sites surveyed in, and near, the Los Vaqueros project area (near Brushy Peak, Alameda and Contra Costa counties). Cumulatively, this species is now known from three localities:

1. Oakley (Contra Costa County),
2. near Brushy Peak (Contra Costa County), and
3. near Brushy Peak (Alameda County).

Habitat Requirements

Leech (1938) describes the type-locality as "a small, shallow, muddy pool amongst *Typha*, on the north side of the railway embankment a few hundred yard from Oakley, Calif. This little pool is not saline, but is much fouled by cattle, and from an accumulation of old tin cans, etc." Although Leech (1938) specifically mentions that the type-locality was "not saline," Jones & Stokes Associates (1992) report that "most occupied sites [near Brushy Peak] are fringed by alkali deposits and are surrounded by salt-tolerant vegetation." In addition, the curved-foot hygrotus diving beetle was found in the drying portions of creeks, and occasionally in stock ponds and troughs, ditches, irrigation canals, and the flowing portions of creeks (Jones & Stokes Associates 1992).

Cuppen (1983) (from work with *Hygrotus* spp. in the Netherlands) reports that the beetles were found in "small water bodies such as peat-ditches, reed-lands, and overgrown ditches where emergent plants are abundant," and from "permanent water bodies such as clay- and sand-canals which have a rich growth of submerged plants and a weak current." While niche separation was reported for two species (i.e., *H. decoratus* and *H. versicolor*), a third (*H.*



Distribution of the Curved-Foot Hygrotus Diving Beetle in California

inequalis) was observed to occupy both habitat types. In general, it appears that although the curved-foot hygrotus diving beetle prefers saline ponds, it may be (like other *Hygrotus* spp.) capable of opportunistic exploitation of a wide variety of habitat types.

Specific biology for this species is not well documented; however, Balduf (1935) summarized extensive work on the family *Dytiscidae*. From Balduf (1935): Dytiscids prefer small, shallow ponds with very little (if any) current, an abundance of vegetation, and numerous small animals. Aquatic vegetation is important to dytiscids, as it provides anchorage as they float submerged, food for potential prey, cover from predators, and the substrate for oviposition. Dytiscids spend most of the time submerged, surfacing intermittently to replenish their air supply, which is stored in a sub-elytral chamber. It is during this exchange that they have been most often observed, "hanging" head-down from the surface of the water. Both larvae and adults are predaceous and carnivorous, feeding on almost anything small enough to eat, including nymphs and larvae of other aquatic insects, small arthropods, and in the case of the larger species, even small fish. The larvae are sometimes referred to as "water tigers" due to their aggression in attacking larger animals.

Although most dytiscids are believed to be univoltine (Balduf 1935), variable duration of larval diapause suggests that on any given day, representatives of various stages of the life cycle may be observed. Larvae may diapause in the mud, and pupation is said to occur in specially constructed cells along the shoreline (Balduf 1935). Some dytiscids overwinter as adults, some in the larval form (Balduf 1935). In the case of ephemeral habitat desiccation, adults may either migrate, or may aestivate in the mud (Balduf 1935, Jones & Stokes Associates 1992).

Adult dytiscids are known to migrate by flight, and have been reported to be phototactic (i.e., orienting and responding to light). Most such flights are attributed to habitat drying, and occur mostly by day during the spring and fall, and by night during the summer (Balduf 1935). However, during recent work with five dytiscids (including one member of the genus *Hygrotus*), by Zalom *et al.* (1980) in California (Butte County) rice paddies, no beetles were collected during daylight hours.

Critical Habitat

No critical habitat has been designated for this species.

Reasons for Decline

The curved-foot hygrotus diving beetle was only recently discovered (1988-89) outside its type-locality, from which it was last collected in 1938 (Leech 1966). Population estimates are inadequate to document a "decline." Its currently documented range and recently reported habitat preference for pools fringed by alkali deposits, suggest that it probably once

inhabited such pools on the floor of the Central Valley and in the margins of the bordering Coast Range. Such alkali grasslands on "hardpan" clay soils (which would have allowed the formation of ephemeral aquatic habitats) are known from the floor of the San Joaquin Valley. Dytiscids are known to migrate by flight, and such pools might have provided a significant amount of suitable habitat. Much suitable habitat has been lost to agricultural and other development activities since the 1800s, thereby contributing to a probable corresponding decline of the species. Holland (1978) estimates that, at the time Europeans arrived in California, there were 6 million acres of vernal pools in the Central Valley; by 1970, approximately 5.4 million acres (90 percent) had been destroyed (Holland 1978, 1988). Holland (1988) estimates that vernal pool habitat loss continues at a rate of 2 to 3 percent per year. The beetle's utilization of other pool types (including the type-locality at Oakley) may represent only opportunistic exploitation of still-available (but less desirable habitat).

In general terms, the restriction of the species to small, widely scattered locations renders individual populations extremely vulnerable to localized disturbance. When there are a limited number of such localities (i.e., two documented localities for the curved-foot hygrotus diving beetle), this risk is even more acute. In addition to those factors contributing to habitat destruction (i.e., agricultural and other development activities), the peculiarities of specific biology (i.e., the species' normal respiratory function at the air-water interface), render it extremely susceptible to potential contamination in surface runoff. While specific toxicities have not been researched, and are not reported, toxicity in and of itself is not necessary to impact the species. The respiratory function may be interfered with by changes in water surface tension, such as might be caused by small quantities of detergents and/or surfactants.

Potential for Occurrence in the PSA

The curved-foot hygrotus diving beetle has been reported from only two locations; one within the Delta (i.e., Oakley, Contra Costa County), and one (i.e., near Brushy Peak, Contra Costa and Alameda counties) within 10 miles of the western margin of the southern Delta. The Kellogg Creek watershed, from which the curved-foot hygrotus diving beetle was recently reported at 10 of 40 sites sampled (Jones & Stokes Associates 1992), drains to a channel which passes just south of Byron. The reported habitat preference for pools "fringed by alkali deposits and ... surrounded by salt-tolerant vegetation," indicates the species might be found in pools remaining in scrub/grasslands at the western margin of the Delta (i.e., Byron Tract). Preliminary reconnaissance surveys conducted during December 1992 revealed the presence of such scrub grasslands (although disturbed) in the ISDP area. In addition, the wide range of habitat apparently tolerated by this species suggests that it may occupy roadside ditches, irrigation canals, and stock ponds including such habitats on Delta islands. Therefore, it is considered possible that the curved-foot hygrotus diving beetle occurs within the ISDP area.

Proposed Survey Methodology

Preliminary survey efforts, including a review of topographic data, soil surveys, and aerial photography (preferably shot during the rainy season), will be conducted to identify potential habitat for the curved-foot hygrotus diving beetle. If potential habitat is found, follow-up survey efforts should be undertaken during the documented adult activity period. Currently, data regarding the schedule of surveys conducted by Hafernik during 1988-89 are unavailable. Previous reports (Leech 1938, 1966) indicate a time frame of August 21 through September 5. The life cycle description provided by Balduf (1935) suggests that the suitable time-frame for sampling may be much less restricted.

Follow-up surveys could include either of the following methods.

1. Black light trapping, as used by Zalom *et al.* (1980) during recent work in California (Butte County) rice paddies, could be undertaken. This method has proven very successful with dytiscids (including *Hygrotus* sp.), and was used to correlate flight activity with body size, air temperature, light intensity, and wind velocity (Zalom *et al.* 1980). This method may be less labor-intensive, but has certain disadvantages: 1) it would not yield a conclusive negative result, as specific response and flight range of the curved-foot hygrotus diving beetle are not documented; 2) it is somewhat capital-intensive, requiring some investment in equipment; 3) this activity must be conducted at night; and most significant, 4) should a positive result be obtained, the precise location of distinct populations would not be accomplished. Should this method be employed, representative samples should be retained, and identified by qualified personnel.

2. Trained and qualified observers may visually examine ponds for the presence of diving beetles. Observers may key upon the distinctive swimming motion (i.e., simultaneous movement of the hind legs, like oars) of the *Dytiscidae* (Borror *et al.* 1976); and upon the unique diving behavior exhibited by *Hygrotus* spp. (Brancucci 1977, english translation). Should beetles be observed, representative samples should be obtained using a dip net, and samples should be identified by qualified personnel.

Middlekauff's Shield-Backed Katydid

Status

Middlekauff's shield-backed katydid (*Idiostatus middlekauffi*) is classified by the USFWS as a Category 2 candidate species.

Distribution

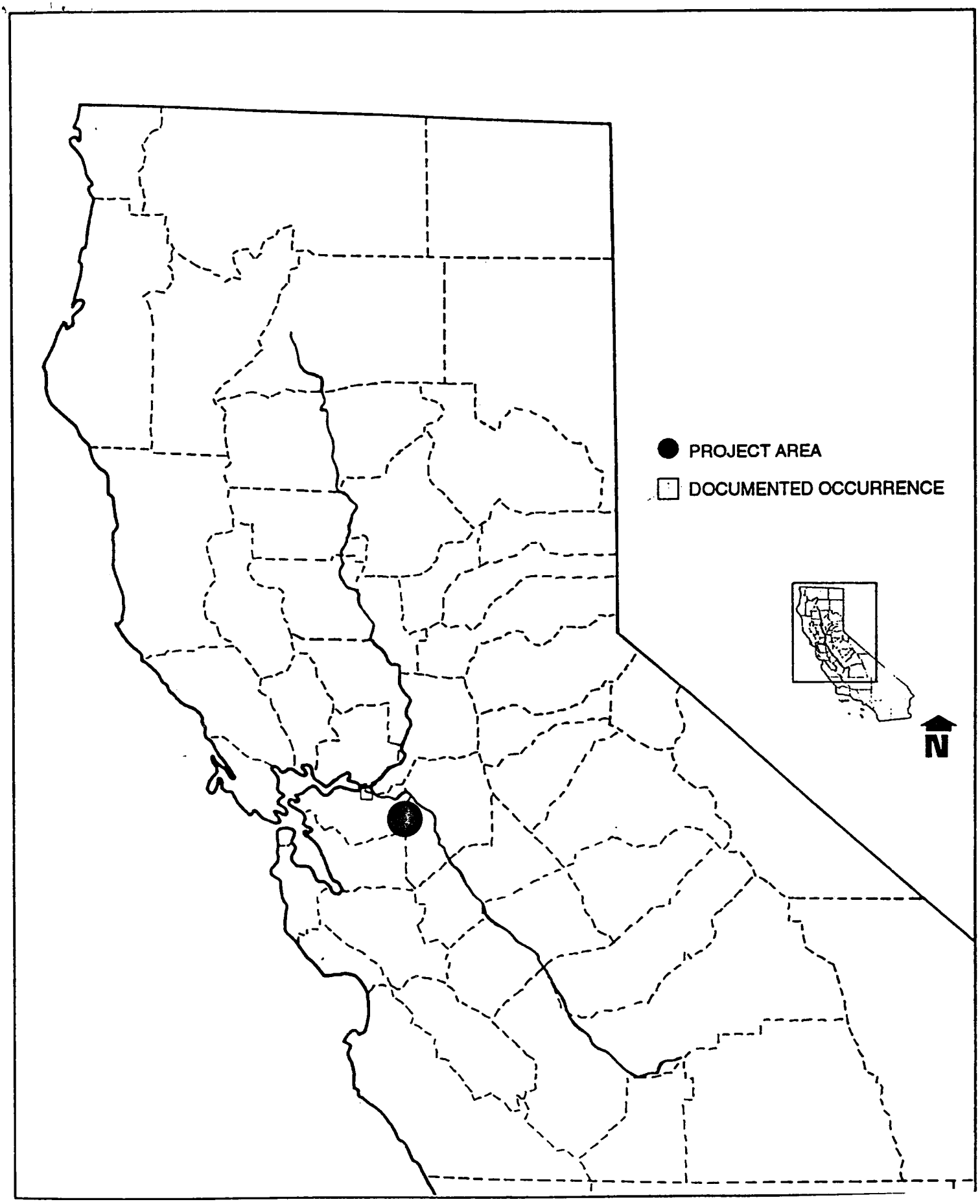
The NDDB (1992) provides a single occurrence record of *Middlekauff's shield-backed katydid* at Antioch, Contra Costa County, last observed in 1965. Rentz (1973), in his original description of the species, reports collections from Antioch on seven occasions:

1. 20 April 1937, by Ross;
2. 29 June 1953, by Marsh and Schuster;
3. 3 July 1953, by Marsh and Schuster;
4. 22 August 1960, by Rentz;
5. 23 June 1961, by Rentz;
6. 17 July 1962, by Rentz; and
7. 3 August 1965, by Rentz.

In addition, during 1965 (August 14), three specimens which may represent Middlekauff's shield-backed katydid were collected high on Mount Diablo (elevations 2,900 and 3,849 feet). Although these specimens exhibited striking similarity to those taken at Antioch, certain morphological differences were evident. Pending additional sampling, Rentz (1973) stopped short of identifying them as Middlekauff's shield-backed katydid. The status of that study is unknown.

Habitat Requirements

Rentz (1973) provides a complete discussion of *Idiostatus* spp., from which the following discussion is summarized. He reports that most species inhabit xeric regions, either mountain tops or deserts, and oviposit directly into the soil to a depth of an inch or more. Eggs apparently diapause for a period of at least one year, and all eggs of a given brood may not hatch in the same year. Eggs hatch in spring and the nymphs may be found abundantly on or near the ground in weedy plant growth. Although adults of the *Aequalis* group (of which Middlekauff's shield-backed katydid is a member) are thamnophilous (i.e., bush-loving), juveniles are not. Larvae mature through 5-7 instars, while feeding upon plant



Distribution of the Middlekauf's Shield-Backed Katydid in California

material. Maturation is completed from early to mid-summer, and *Idiostatus* spp. are not believed to overwinter in the larval form.

Middlekauff's shield-backed katydid was not found to be associated with any particular plant species, but it does prefer a bush habitat, and reportedly prefers the following species, which were found in isolated stands at Antioch: *Lotus purshianus, L. scoparius, Erysimum capitatum* var. *angustatum, Eriogonum latifolium, Croton californicus, Grindelia humilis, Gutierrezia californica*, and *Hemzonia kelloggii*. "Not a single individual was found in grass situation but rather along the periphery of the large field and along the roadside where bush lupine and shrubbery may be found" (Rentz 1973).

Critical Habitat

No critical habitat has been designated for this species. The reported type-locality (Antioch Dunes), is legally protected as critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). This area is now known as the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

Population estimates for Middlekauff's shield-backed katydid are inadequate to document a "decline." If restricted to the Antioch Dunes, the species probably experienced significant historical reduction in available habitat due to agricultural and economic development. Current status of the population at Antioch is unknown. Powell (1981) noted that "several of the species described from Antioch are not known to have been observed there since the industrial build-up in the 1940s and early 1950s. In addition, from more recent work, he comments upon "a general decline in species diversity in some families with sand dune based biologies." If it existed prehistorically at other dune locales in the Central Valley and Coast Ranges, its habitat probably has been similarly reduced by urban development and flood control activities.

Potential for Occurrence in the PSA

It is unfortunate that results from further study of the potential Mount Diablo population are not reported. If those specimens were, in fact, Middlekauff's shield-backed katydid, a broad habitat tolerance is suggested, and the species may have dispersed over a wide area. The lack of specific plant associations supports this possibility, and in general, *Idiostatus* spp. are believed to be omnivores (Rentz 1973). Thus, the species may exist in other locales within the Delta, where there are significant accumulations of loose sand supporting shrubs and forbs (e.g., long-standing dredge spoils disposal areas).

Proposed Survey Methodology

Reconnaissance surveys will be conducted to identify suitable habitat associations (i.e., sandy soil supporting shrubs and forbs). These surveys will be conducted in association with surveys for other sensitive species.

Should suitable habitat be located, follow-up surveys should be conducted by qualified personnel during the documented adult activity season, which Rentz (1973) (despite a somewhat broader time-frame defined by collection records) reports as June 23 to August 3. Follow-up survey efforts should consist of observing potentially-occupied localities beginning at dusk and continuing for 2 to 3 hours since Middlekauff's shield-backed katydid is nocturnal. Observation may cue upon both audible and visual cues. According to Rentz (1973), males will stridulate (i.e., "sing"), beginning about 30 minutes after sundown (often before complete darkness). During stridulation, they will typically occupy prominent positions on the landscape (e.g., high in bushes or atop rocks). They will not sing under a full moon in a clear sky. The song is described as a "low buzz audible for only 10-15 feet." Should their song not be audible, bushes should be visually examined (at close range) using a flashlight (reported to disturb them little). Should individuals be located, representatives should be collected, and identified by qualified personnel.

Hurd's Metapogon Robber Fly

Status

Hurd's metapogon robber fly (*Metapogon hurdi*) is classified by the USFWS as a Category 2 candidate species.

Distribution

The NDDB (1992) provides no records for the distribution of Hurd's metapogon robber fly. Powell (1981) indicated that it was described by Wilcox (1964) from specimens taken at Antioch, but is also known from other arid places in the Central Valley. Wilcox (1964) indicated that type-material was examined from Antioch, Contra Costa County (taken November 1, 1946 and November 7-16, 1958), and Fresno, Fresno County (November 3-29, 1922). Powell (1981) reported that it was last collected from Antioch in 1977. These records are indicated on the distribution map.

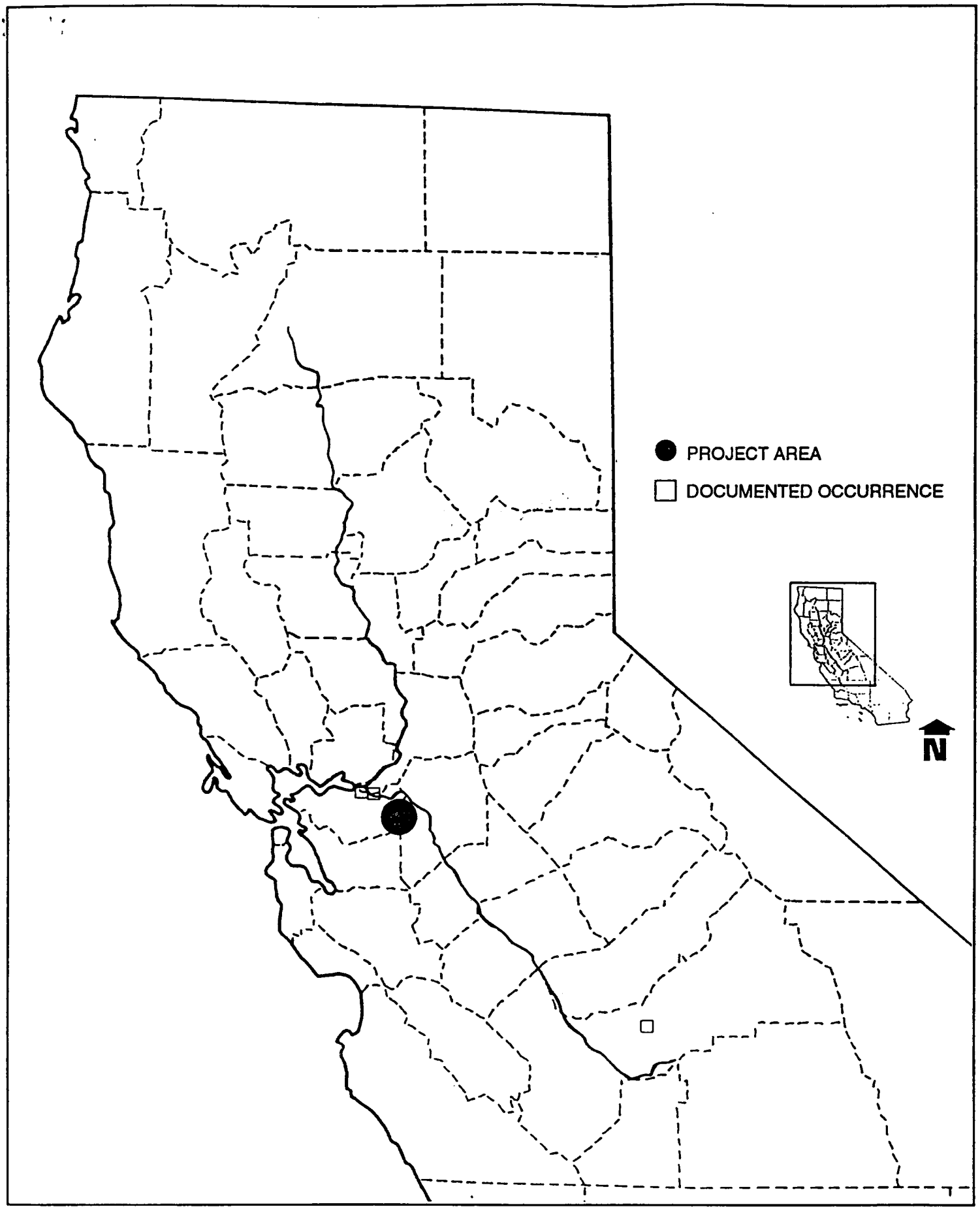
Habitat Requirements

Specific biology for Hurd's metapogon robber fly is not reported. Hull (1962) indicated that the majority of robber flies (*Asilidae*) "frequent dry and sandy areas." Further:

> "*... even in desert or semidesert country the small drains of dry st[r]eam beds attract the greatest number, and sometimes the entire robber fly population of a region will be restricted to such places, which also have the maximum vegetation and the greatest population of insects upon which the flies feed*".

Adult asilids are said to be active several hours after sun up, and are occasionally active until sunset (Hull 1962). Most are active from 10 a.m. until 2 p.m., and are strongly affected by hot, bright sunshine (Hull 1962.) Wilcox (1964) reported that members of this genus are infrequently collected because they are only found in fall, winter, and early spring. All specimens reported by Wilcox (1964) were collected during November.

Asilid life spans range from a week to six months (Hull 1962). The larvae of many genera live in the soil, where they may feed upon either vegetable matter or other insect larvae (Hull 1962).



Distribution of the Hurd's Metapogon Robber Fly in California

Critical Habitat

No critical habitat has been defined for Hurd's metapogon robber fly. The reported type-locality (i.e, Antioch Dunes), is legally protected as critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). This area is now known as the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

Population estimates for this species are inadequate to document a "decline." Powell (1981) reported that the species has been collected as recently as 1977, at Antioch (one of only two documented locations for the species). Limiting factors for population size in asilids are not known (Hull 1962). Regarding adults, lack of available prey does not seem to be a factor; however, the larvae may find food scarcity a limiting factor (Hull 1962). The extremely specific microhabitat associations reported for *Asilidae* by Hull (1962) support this possibility.

The specific location of the "Fresno" collection (and the status of its population) is not known. Although the specific location is not reported, the historical occurrence of the species near Fresno suggests that it might be able to utilize a broader variety of habitats than those once found at Antioch. Two other dune-inhabiting species are reported from locations "near" (i.e., within 60 miles of) Fresno: the Ciervo Aegialian scarab beetle (*Aegialia (Aegialia) concinna*), and the San Joaquin dune beetle (*Coelus gracilis*). Both occupy isolated dunes in the eastern margin of the Coast Range, which are hypothesized to represent shoreline remaining from a prehistoric extension of the Pacific Ocean into the San Joaquin Valley (Doyen 1976). Both of these beetles have been reported from Antioch suggesting possible migration within drainage systems. It appears that Hurd's metapogon robber fly may have followed a similar route.

In general, suitable habitat for dune-inhabiting species in the San Joaquin Valley is limited and greatly fragmented. Historically, habitat destruction due to agricultural development, flood control, and water management in the San Joaquin Valley have reduced the availability of suitable habitat, thus contributing to a probable decline of the species. In addition, there is widespread concern regarding habitat destruction due to human disturbance at remaining dune systems (Doyen 1976, Powell 1981).

Potential for Occurrence in the PSA

Due to the lack of suitable relict dune habitat, the potential for occurrence of Hurd's metapogon robber fly in the ISDP area is considered unlikely. In general, the level of

disturbance in the Delta is believed to preclude the possibility of suitable habitat remaining. Despite extensive work in the area, the habitat type has not been reported, and preliminary reconnaissance surveys have identified none. Although the species may have the ability to utilize dune formations of various origins supporting various plant associations, its potentially extremely specific microhabitat associations argue against its ability to exploit recently-formed and/or temporary dune locations (e.g., dredge spoils disposal sites), and disturbed sandy habitats.

Proposed Survey Methodology

Although, occurrence in the PSA is considered unlikely, researchers conducting surveys for other sensitive species will be searching for dune habitat, especially on Byron Tract. It is important to note that such habitat should constitute true dune (including riverine deposits), and not recently formed and/or disturbed sandy habitat.

Should dune habitats be identified, follow-up surveys for Hurd's metapogon robber fly should be conducted during the documented adult activity season (November). These surveys should consist of site observation by qualified observers during the species' known activity period, from 10 a.m. to 2 p.m. In the event of observed adult asilid activity, representative samples should be collected, and identified by qualified personnel.

Antioch Mutillid Wasp

Status

The Antioch mutillid wasp (*Myrmosula pacifica*) is classified by the USFWS as a Category 2 candidate species.

Distribution

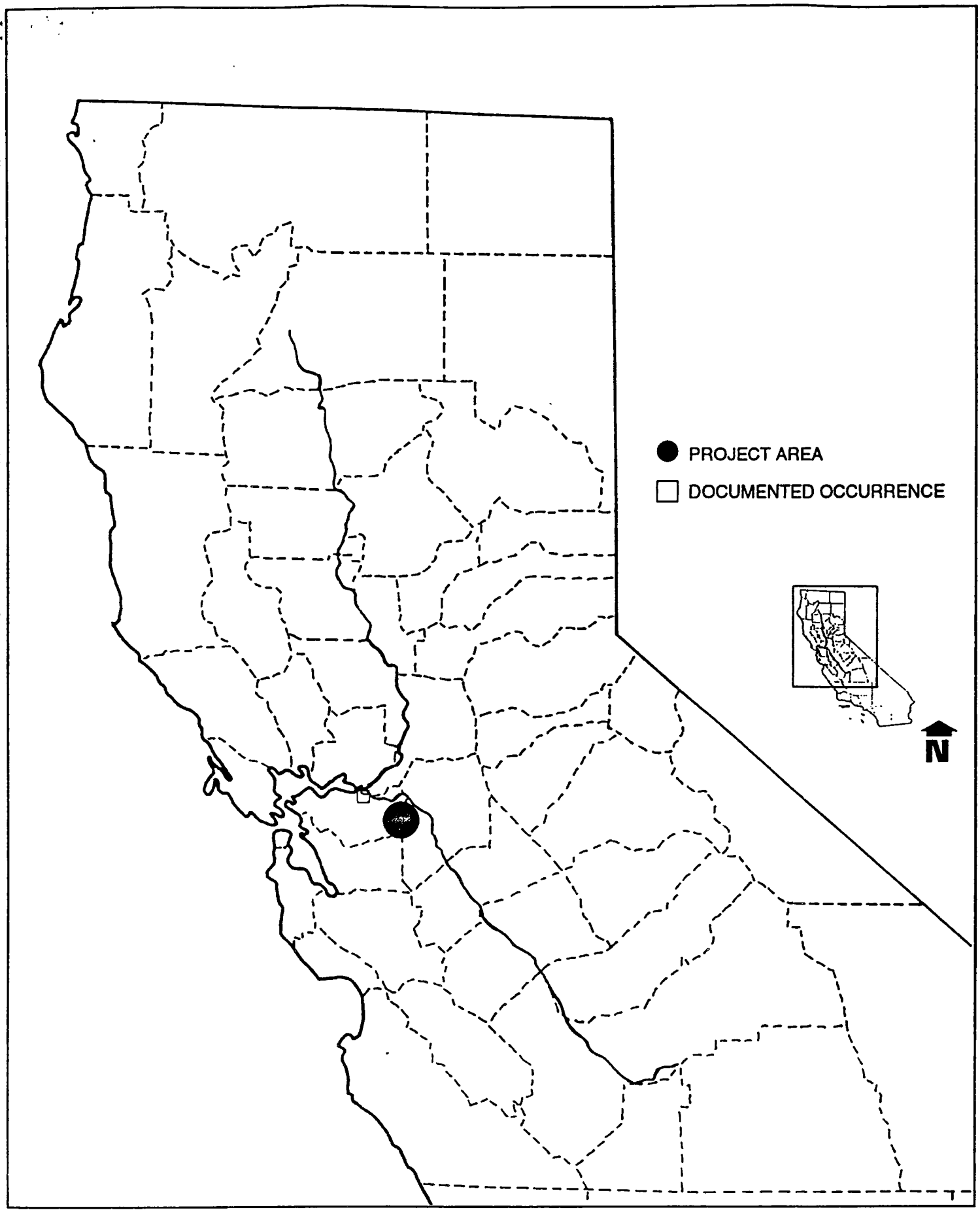
The NDDB (1992) provides a single general occurrence record for the Antioch mutillid wasp from Antioch, Contra Costa County. The basis for this record (Powell 1981) indicates that it was described by Mickel in 1940, and was last observed at Antioch in 1952. Mickel (1940) reported the type-material was collected from Antioch on September 4, 1938, by Van Dyke. Despite some taxonomic confusion (Mickel 1940, Wasbauer 1973, Krombein *et al.* 1979), the species is still considered valid, and is reported only from Antioch.

Habitat Requirements

Specific biology for the Antioch mutillid wasp is not reported. Approximately 100 mutillids occur in California; most are nocturnal and restricted to the deserts (Powell and Hogue 1979). Commonly known as "velvet ants" due to their distinctive appearance, they are generally found in "open areas" and "chiefly in arid areas" (Borror *et al.* 1976), where the wingless females will roam over the ground searching for the nests of ground-nesting wasps and bees (Powell and Hogue 1979, Krombein *et al.* 1979). Once a nest is found, the female will oviposit into the host's larval cell, and eggs will hatch to parasitize the larvae. Females have a significant sting, and are sometimes referred to as "cow-killers" or "mule-killers." Males, often much larger than the females, have wings (Wasbauer 1973). Due to their color (described as "pale, ferruginous, almost testaceous" by Mickel 1940) it is presumed that this species is active nocturnally (Powell and Hogue 1979).

Critical Habitat

No critical habitat has been defined for the Antioch mutillid wasp. The reported type-locality (i.e, Antioch Dunes), is legally protected as critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* spp. *howellii*) (USFWS 1980). This area is now known as the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990).



Distribution of the Antioch Mutillid Wasp in California

Reasons for Decline

Population estimates for the Antioch mutillid wasp are inadequate to document a "decline." Notably, despite recent work, the species has not been observed at Antioch (its only known locality) since 1952 (Powell 1981). In addition to its own limiting factors (which are unreported), the Antioch mutillid wasp, reproductively dependent upon other ground-nesting insects (i.e., wasps and bees), is vulnerable to whatever conditions limit or restrict its host species. This factor, in effect, multiplies the Antioch mutillid wasp's vulnerability to disturbance. Powell (1981) noted that "several of the species described from Antioch are not known to have been observed there since the industrial build-up in the 1940s and early 1950s. In addition, he comments upon "a general decline in species diversity in some families with sand dune-based biologies."

Potential for Occurrence in the PSA

As particular associations and host-specificity for the Antioch mutillid wasp are not known, it is safest to assume that the species may exist within the PSA. Probably, true dunes with desert associations would be preferred. Minimally, it appears that this species would require sandy, "desert-like" conditions with a healthy population of other ground-nesting wasps or bees (which would normally also imply a population of flowering vegetation).

In general, the level of disturbance in the Delta is believed to preclude the possibility of suitable habitat remaining. Despite extensive work in the area, the dune habitat type has not been reported, and preliminary reconnaissance surveys have identified none. Although the species may have the ability to utilize dune formations of various origins supporting various plant associations, the inability of females to fly (and thus readily disperse), and the potential for host-specificity argue against its ability to exploit recently-formed and/or temporary dune locations (e.g., dredge spoils disposal sites), and disturbed sandy habitats.

Proposed Survey Methodology

Reconnaissance surveys, conducted in association with surveys for other sensitive species, will determine whether minimally suitable habitat (i.e., sandy conditions with flowering vegetation utilized by ground-nesting wasps or bees) is present within the PSA.

Should suitable habitat be identified, follow-up surveys should be conducted during the documented adult activity season (known from a single record as September 4). These surveys should consist of nocturnal site observation by trained observers. In the event of observed adult mutillid activity, representative samples should be collected and identified by qualified personnel.

Yellow-Banded Andrenid Bee

Status

The yellow-banded andrenid bee (*Perdita hirticeps luteocincta*) is classified by the USFWS as a Category 2 candidate species.

Distribution

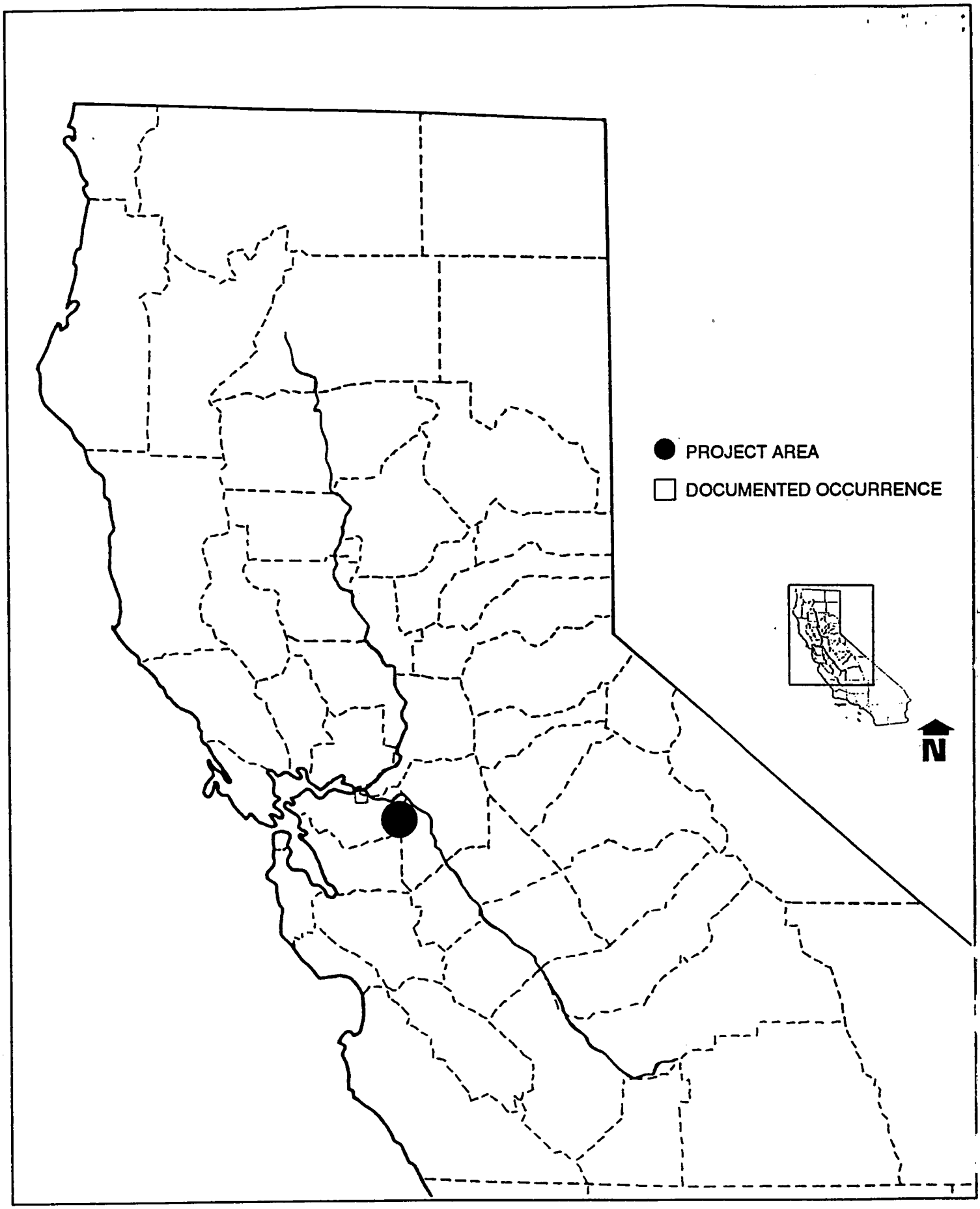
The NDDB (1992) provides only one general record of the yellow-banded andrenid bee occurring at Antioch, Contra Costa County, where it was last observed in 1936 (Powell 1981). Timberlake (1960) described it as a subspecies of *P. hirticeps* from which it differs only in coloration. It was described from females collected at Antioch on September 9, 1935 and September 8, 1936 (Timberlake 1960).

Habitat Requirements

Specific biology for the yellow-banded andrenid bee is not reported; however, the nesting biology and behavior of several *Perdita* spp. have received much recent attention (Barrows *et al.* 1976, Bennet and Breed 1985, Danforth 1989, 1991a,b, Danforth and Neff 1992, Eickwort 1977, Linsley 1958, Michener 1963, Neff and Danforth 1992, Torchio 1975). Much of the following discussion is taken from Rozen (1967) and has been supplemented, where significant, by more recent sources.

All members of the subfamily *Panurginae* nest in the ground and prefer sites that have little vegetation and are exposed to the sun (Rozen 1967). Although most panurgines prefer horizontal nesting sites, members of the genus *Perdita* show different specific preferences, from horizontal to vertical (Rozen 1967). There is considerable variation in soil texture at panurgine nesting sites as well, ranging from the hard-packed soils (preferred by most) to loose sand (Rozen 1967). The soil at the nesting cell level is usually "visibly wet," even in desert regions (Rozen 1967).

Panurgines are solitary nesters (i.e., a single female per nest); but, where populations are large (or habitat limited), they may aggregate (Rozen 1967). Females may construct single- or multi-celled nests (Rozen 1967). The nesting cells of most panurgines (with vertical burrows) are found 5-20 cm (2-8 inches) deep. All panurgines construct a cell, provision it with a pollen-nectar mass (usually a ball), deposit an egg, and close the cell (Rozen 1967). The egg stage is relatively short, ranging from 5-14 days (where known)(Rozen 1967). The larval activity phase, during which larvae consume the pollen nectar mass, may last 2-6 weeks (Rozen 1967). After that, overwintering usually occurs as a quiescent larvae. Torchio (1975) reports that larval diapause for *Perdita nuda* may last as long as 35 months,



Distribution of the Yellow-Banded Andrenid Bee in California

and that not all larvae pupate in any given year. These types of adaptations are common to species inhabiting desert/arid regions. The subsequent pupal phase may last from 12-18 days (Rozen 1967).

The nesting sites of known univoltine species (i.e., one brood per year, as produced by most panurgines) are active for only about one month (during the blooming period of preferred pollen plants) (Rozen 1967). During this period, adults mate, construct and provision nests, and deposit eggs. Most panurgines are reported as oligolectic (i.e., preferring the pollen of only a few types of flowers), but may visit a wider variety of flowers to obtain nectar (Rozen 1967). The yellow-banded andrenid bee is reported to "visit" *Gutierrezia californica*; however, its activities at this plant (i.e., pollen versus nectar collection) are unreported. Krombein *et al.* (1979) consider that the pollen source is "unknown." Daily adult flight activity, mostly associated with provisioning the nests, usually occurs during daylight hours (Rozen 1967). However, several species of *Perdita* are reported as crepuscular (i.e., active at twilight) (Rozen 1967). Females overnight within the nesting burrows; males may overnight on plants, in crevices in the ground, or may excavate small burrows within the female's nesting burrow.

Critical Habitat

No critical habitat has been defined for the yellow-banded andrenid bee. The reported type-locality (i.e, Antioch Dunes), is legally protected as critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). This area is now known as the Antioch National Wildlife Reserve which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

Population estimates for the yellow-banded andrenid bee are inadequate to document a "decline." However, despite recent work (Powell 1981), it has been unreported since 1936. Apparently it has been extirpated from Antioch (its only reported location). Powell (1981) notes that several of the species described from Antioch are not known to have been observed there since the industrial build-up in the 1940s and early 1950s, during which the majority of the dune system was lost. In addition, from more recent work, he comments upon "a general decline in species diversity in some families with sand dune-based biologies."

Potential for Occurrence in the PSA

Due to probably very specific plant associations, this species probably is restricted to very specific habitat associations, and its potential for dispersal to other locales is slight. The only specific association reported is with *Gutierrezia californica*, a plant with desert affinities (Timberlake 1960, Powell 1981). Thus, the yellow-banded andrenid bee is probably not distributed outside of the Antioch Dune system (where it is now considered extirpated).

Due to the lack of suitable relict dune habitat, the potential for occurrence of the yellow-banded andrenid bee in the ISDP area is considered unlikely. In general, the level of disturbance in the Delta is believed to preclude the possibility of suitable habitat remaining. Despite extensive work in the area, no dune habitat has been reported, and preliminary reconnaissance surveys have identified none.

Proposed Survey Methodology

Although, occurrence in the PSA is considered unlikely, researchers conducting surveys for other sensitive species will identify and report coincidentally encountered relict dune habitat, especially that supporting *Gutierrezia californica*. It is important to note that such habitat should constitute "true" relict dune, and not recently formed and/or disturbed sandy habitat.

Should suitable habitat be identified in "significant" quantity and distribution, field surveys during the adult mating/nesting season (known only from two records as September 8 and 9) should be conducted. If implemented, these surveys should consist of visual observation of potential sites from morning to midnight (due to the fact that specific diel periodicities are not documented). Should individuals be located, representatives should be collected and identified by qualified personnel.

Antioch Andrenid Bee

Status

The Antioch andrenid bee (*Perdita scitula antiochensis*) is classified by the USFWS as a Category 2 candidate species.

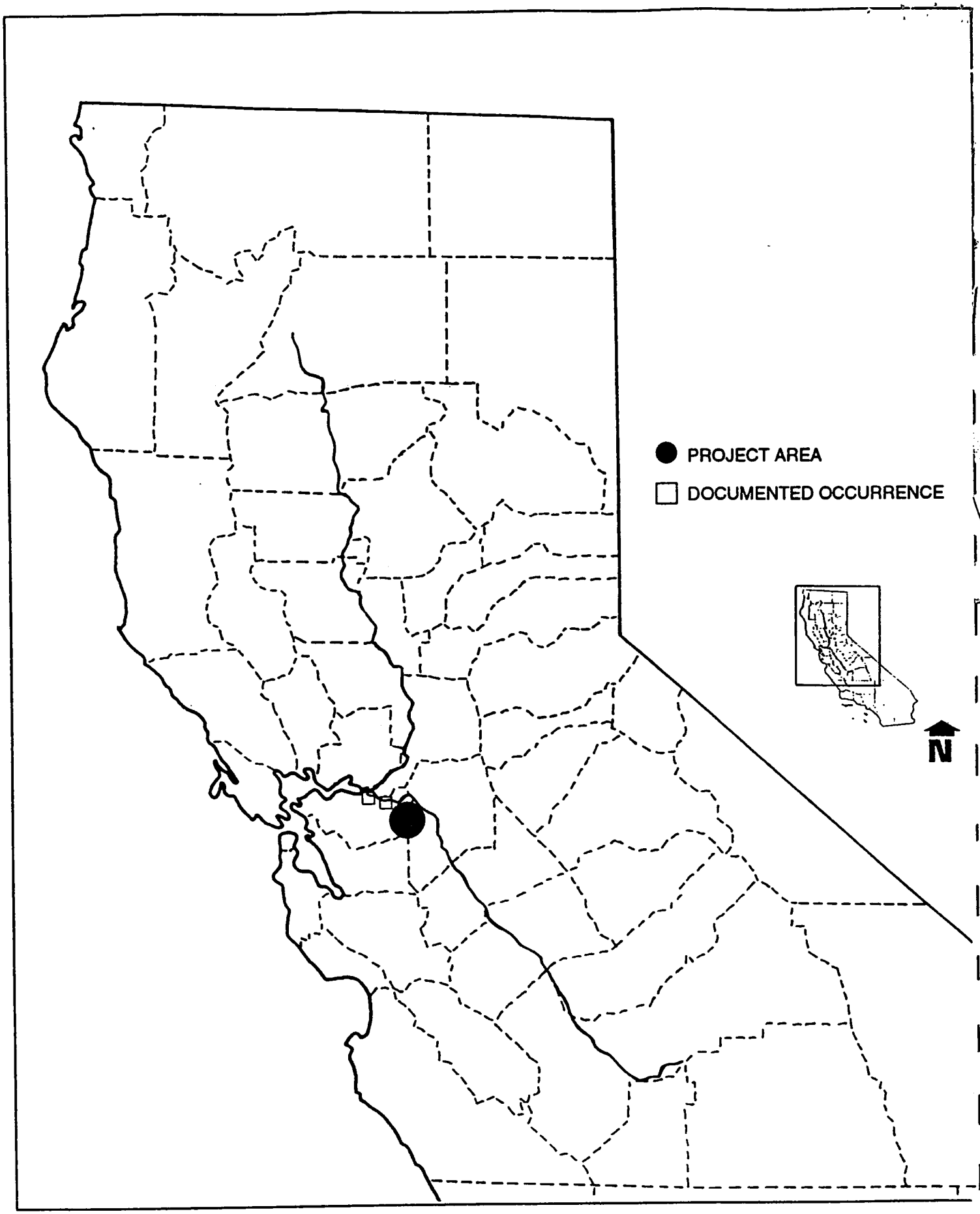
Distribution

The NDDB (1992) provides only a general record of the Antioch andrenid bee occurring at Antioch, Contra Costa County (i.e., the type-locality), where it was last observed in 1977 (Powell 1981). Timberlake (1960) described it as a subspecies of *P. scitula*, with which it "agrees closely," despite being smaller. He examined type-material from the Antioch Dunes collected on the dates listed below. In addition, Timberlake examined a female collected from Oakley (Contra Costa County) on October 23, 1938, by MacSwain. The distribution map is based upon these records.

1. September 9, 1935, by Bohart
2. September 8, 1936, by Michener
3. September 10, 1936, by Bohart and Bohart
4. September 12, 1936, by Linsley (original type-material)
5. October 18, 1936, by Dickson
6. September 22, 1938, by MacSwain
7. September 8, 1948, by MacSwain
8. September 8, 1948, by Hurd
9. September 22, 1954, by Hurd
10. October 25, 1955, by Burdick
11. September 4, 1958, by Kellen

Habitat Requirements

Specific biology for the Antioch andrenid bee is not reported. However, the nesting biology and behavior of several *Perdita* spp. have received much recent attention (Barrows *et al.* 1976, Bennet and Breed 1985, Danforth 1989, 1991a,b, Danforth and Neff 1992, Eickwort 1977, Linsley 1958, Michener 1963, Neff and Danforth 1992, Torchio 1975). Much of the following discussion is taken from Rozen (1967), and has been supplemented, where significant, by more recent sources.



Distribution of the Antioch Andrenid Bee in California

All members of the subfamily *Panurginae* nest in the ground and prefer sites that have little vegetation and are exposed to the sun (Rozen 1967). Although most panurgines prefer horizontal nesting sites, members of the genus *Perdita* show different specific preferences, from horizontal to vertical (Rozen 1967). There is considerable variation in soil texture at panurgine nesting sites as well, ranging from the hard-packed soils (preferred by most) to loose sand (Rozen 1967). The soil at the nesting cell level is usually "visibly wet," even in desert regions (Rozen 1967).

Panurgines are solitary nesters (i.e., a single female per nest); but, where populations are large (or habitat limited) they may aggregate (Rozen 1967). Females may construct single- or multi-celled nests (Rozen 1967). The nesting cells of most panurgines (with vertical burrows) are found at depths of 5-20 cm (2-8 inches). All panurgines construct a cell, provision it with a pollen-nectar mass (usually a ball), deposit an egg, and close the cell (Rozen 1967). The egg stage is relatively short, ranging from 5-14 days (where known) (Rozen 1967). The larval activity phase, during which larvae consume the pollen nectar mass, may last 2-6 weeks (Rozen 1967). After that, overwintering usually occurs as a quiescent larvae. Torchio (1975) reported that larval diapause for *Perdita nuda* may last as long as 35 months and that not all larvae pupate in any given year. These types of adaptations are common to species inhabiting desert/arid regions. The subsequent pupal phase may last from 12-18 days (Rozen 1967).

The nesting sites of known univoltine species (i.e., one brood per year, as produced by most panurgines) are active for only about one month (during the blooming period of preferred pollen plants) (Rozen 1967). During this period, adults mate, construct and provision nests, and deposit eggs. Most panurgines are reported as oligolectic (i.e., preferring the pollen of only a few types of flowers), but may visit a wider variety of flowers to obtain nectar (Rozen 1967). The Antioch andrenid bee is reported to "visit" *Eriogonum* sp., *Gutierrezia californica*, *Heterotheca grandiflora*, and *Lessingia glandulifera*; however, its activities at this plant (i.e., pollen versus nectar collection) are unreported (Krombein *et al.* 1979, Timberlake 1960). Krombein *et al.* (1979) considered that the pollen source is "unknown." Daily adult flight activity, mostly associated with provisioning the nests, usually occurs during daylight hours (Rozen 1967). However, several species of *Perdita* are reported as crepuscular (i.e., active at twilight) (Rozen 1967). Females overnight within the nesting burrows; males may overnight on plants, in crevices in the ground, or may excavate small burrows within the female's nesting burrow.

Critical Habitat

No critical habitat has been defined for this species. The reported type-locality (i.e, Antioch Dunes), is legally protected as critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). This area is now known as the Antioch National Wildlife Reserve which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

Population estimates for the Antioch andrenid bee are inadequate to document a "decline." The species has been collected from Antioch as recently as 1977 (Powell 1981). If the species is restricted to Antioch (as the distribution record and reported desert plant affinities strongly suggest), then it probably suffered a historical decline during the 1940s and early 1950s, as the majority of the Antioch Dunes were lost to development (Powell 1981).

Potential for Occurrence in the PSA

Due to probably very specific plant associations (panurgines are reported as oligolectic), this species is probably restricted to very specific habitat associations, and its potential for dispersal to other locales is slight. Specific associations are reported with *Eriogonum* sp., *Gutierrezia californica, Heterotheca grandiflora,* and *Lessingia glandulifera*, all plants with desert affinities (Timberlake 1960, Krombein *et al.* 1979, Powell 1981). Thus, the Antioch andrenid bee is probably not distributed outside of the remaining Antioch Dune system.

Due to the lack of suitable relict dune habitat, the potential for occurrence of the Antioch andrenid bee in the ISDP area is considered unlikely. In general, the level of disturbance in the Delta is believed to preclude the possibility of suitable habitat remaining. Despite extensive work in the area, the habitat type has not been reported and preliminary reconnaissance surveys have identified none.

Proposed Survey Methodology

Although, occurrence in the PSA is considered unlikely, researchers conducting surveys for other sensitive species will identify and report coincidentally encountered relict dune habitat, especially that supporting *Eriogonum* sp., *Gutierrezia californica, Heterotheca grandiflora*, and/or *Lessingia glandulifera*. It is important to note that such habitat should constitute "true" relict dune, and not recently formed and/or disturbed sandy habitat.

Should suitable habitat be identified in "significant" quantity and distribution, field surveys during the adult mating/nesting season (known only from two records as September 4 and October 25) should be conducted. If implemented, these surveys should consist of visual observation of potential sites from morning to midnight (due to the fact that specific diel periodicities are not documented). Should individuals be located, representatives should be collected and identified by qualified personnel.

Antioch Sphecid Wasp

Status

The Antioch sphecid wasp (*Philanthus nasalis*) is classified by the USFWS as a Category 2 candidate species.

Distribution

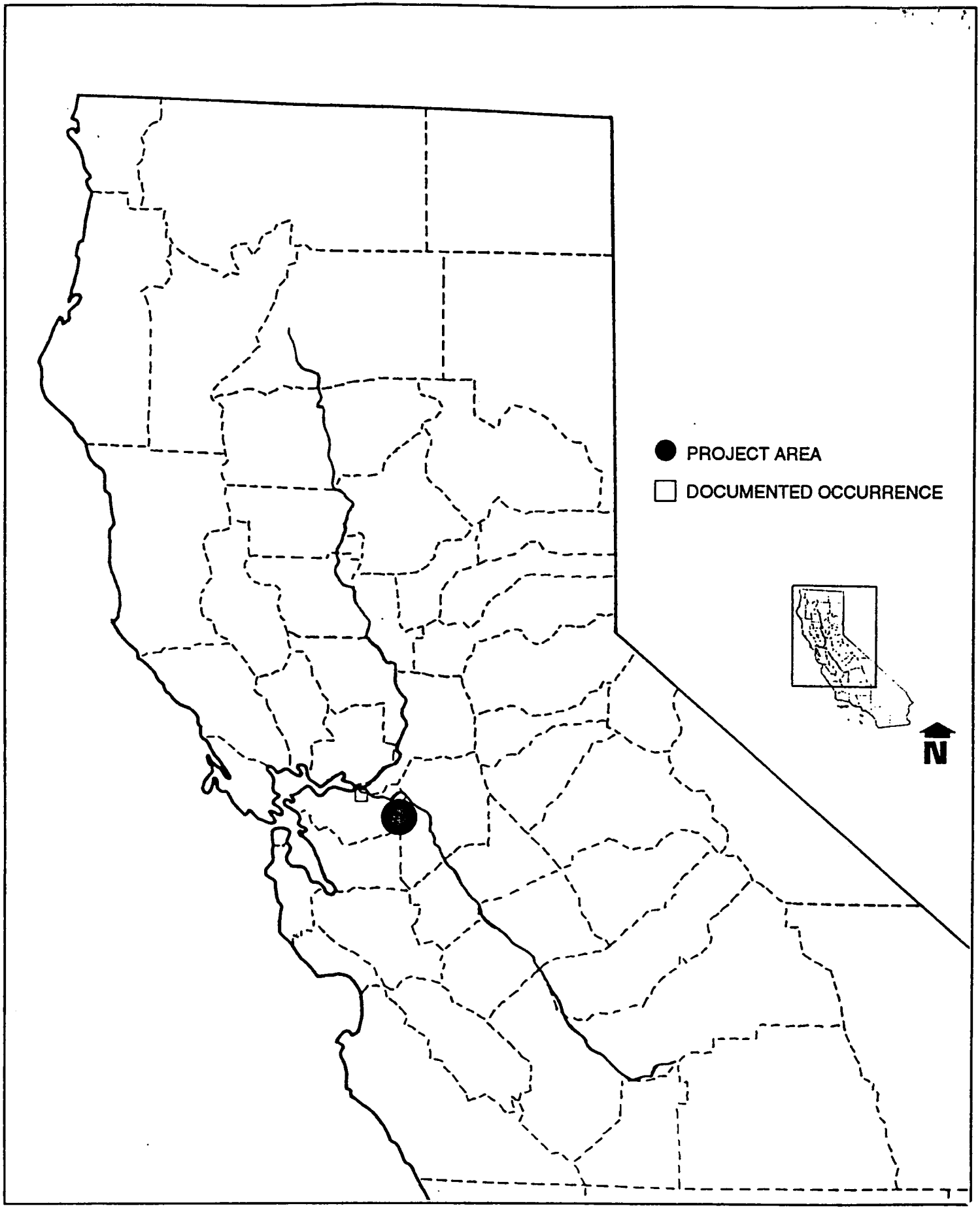
The Antioch sphecid wasp is reported only from "Antioch, Contra Costa Co., California" (Bohart 1972). It was described by Bohart, from a collection made in 1954 by M. Wasbauer (Bohart 1972). No records of this species are included in the NDDB (1992).

Habitat Requirements

Aside from its description, no specific work has been conducted regarding the Antioch sphecid wasp; however, considerable work has been undertaken regarding other sphecid wasps (or "digger wasps"). With few exceptions (i.e., opportunistic burrow exploitation and nesting aggregations are reported), digger wasps are solitary ground-nesters (Borror *et al.* 1976), which provision the overwintering cells of their developing larvae with other insects.

Members of the genus *Philanthus* are "lovers of flowers" (i.e., the Greek translation for the generic name) (Evans and O'Neill 1991). This is likely for two reasons: 1) adults feed exclusively upon the nectar, and 2) females hunt for other insects with which to provision larval development cells. Members of the tribe *Philanthini* (as are *Philanthus* spp.) reportedly prey exclusively upon *Hymenoptera* (Bohart and Menke 1976). In *Philanthus* spp., there is a marked preference reported for bees (particularly *Halictidae* and *Anthophoridae*) (Bohart and Menke 1976), hence the common name "beewolves." However, *Philanthus* spp. are not believed to be prey-specific (Bohart and Menke 1976). In general, *Philanthus* spp. inhabit relatively barren areas of easily-excavated sandy soils (Evans and O'Neill 1991, Bohart and Menke 1976). Nesting aggregations and the repeated use of the same habitat by succeeding generations (believed due to limited availability of suitable burrowing habitat) are common (Evans and O'Neill 1991, Bohart and Menke 1976).

While niche- and/or habitat-specificity for the Antioch sphecid wasp have not been researched, a high degree of niche-specificity in terms of behavior (i.e., activity periods), prey selection, and morphology (particularly body size) is believed to have evolved in *Philanthus* in response to competition for limited resources (i.e., suitable burrowing soil) (Evans and O'Neill 1991). Antioch sphecid wasp adults were collected from buckwheat (i.e., *Eriogonum* spp.) at Antioch from September 25 to October 25, 1954 (Bohart 1972).



Distribution of the Antioch Sphecid Wasp in California

Critical Habitat

No critical habitat has been defined for the Antioch sphecid wasp. The type-locality (although reported only as Antioch and presumed to be the Antioch Dunes), is legally protected as critical habitat defined in August, 1978 for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) (USFWS 1980). This area is now known as the Antioch National Wildlife Reserve which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

As work with this species has been limited, there has been no documented "decline." As it is reported only from the once-large Antioch Dunes (which would have offered an expanse of relatively barren, loose, sandy soil), it is presumed that as agricultural and economic development activities encroached upon the dune system, the species also may have experienced a decline.

Potential for Occurrence in the PSA

The Antioch sphecid wasp has only been reported from the Antioch Dunes, where it was collected from *Eriogonum* spp. This fact is used to support the contention that the species is limited to this habitat. However, academic research has not specifically targeted the species and adequate survey effort outside of the dune system may not have been directed at this species.

While host plant specificity is relatively common among insects, and a generally high degree of niche-specificity is postulated for the genus (Evans and O'Neill 1991), neither host plant-specificity nor prey-specificity is reported for this genus. In fact, prey-specificity has been discounted, and prey selection is reported to be more closely-correlated with body size (Bohart and Menke 1976). The reported collection of the Antioch sphecid wasp from *Eriogonum* may represent opportunistic exploitation of readily-available plant material for foraging, resting, and/or hunting of prey.

In general, the only habitat requirement seems to be the presence of barren sandy soils in proximity to flowering plants. This association may be relatively common in the Delta where soils remain relatively dry and undisturbed (e.g., land sides of levees, and/or dredge spoils areas). Antioch sphecid wasps may exist outside of the dune system in such habitats. Females of *Philanthus* have been reported to fly in excess of 1 km to relocate their nests when released in unfamiliar territory (Bohart and Menke 1976). The flight range of males, reported to be responsible for nesting site selection (Evans and O'Neill 1991), is unknown but is assumed to be similar. For these reasons, it is possible that the species may be more widely distributed in the Delta than current data indicate.

Proposed Survey Methodology

Reconnaissance surveys will be conducted to identify suitable nesting habitat associations (i.e., barren, loose, sandy soil near flowering plants). If such surveys are conducted during the documented adult activity season (September 25 to October 25), observers may key upon visible burrows. However, burrows may only be evident during this season, and may not be visible even then, due to inadequate soil moisture/consolidation to permit burrow entrance stabilization. Should burrows be evident, they would most probably appear as small "nail holes" (approximate diameter 3-5 mm), and may, or may not, be surrounded by a mound of excavated soil.

Despite reportedly distinct and obvious coloration (i.e., white markings), their relatively small size (length = 8.0 mm - 11.5 mm) (Bohart 1972) indicated the need for a trained observer to conduct field surveys. Surveys for resting/flying adults should be conducted on non-windy days during the adult activity period (i.e., from September 25 to October 25), in and around suitable nesting habitat. While adults were reportedly collected from *Eriogonum* spp., niche-specificity is not documented (and should not be assumed). It is recommended that a minimum observation time of one field-day equivalent per week per habitat locale be conducted prior to reporting a negative result. Due to the potential for diel periodicities in behavior (reported for males in Evans and O'Neill 1991), field day equivalents should span daylight hours.

Delta June Beetle

Status

The Delta June beetle (*Polyphylla stellata*) is designated by the USFWS as a Category 2 candidate species.

Distribution

The NDDB (1992) provides no data regarding the distribution of *P. stellata*. Recently described by Young (1986) it is known only from the following records:

1. Carmichael, Sacramento County (i.e., the type-locality from which it was collected on July 11, 1959, by T.H. Gantenbein.);
2. Carmichael, Sacramento County (July 21, 1956, by R.E. Darby);
3. Antioch, Contra Costa County (July 3, 1953, G.E. Marsh and R.O. Schuster); and
4. Antioch, Contra Costa County (July 30, 1953, R.O.Schuster).

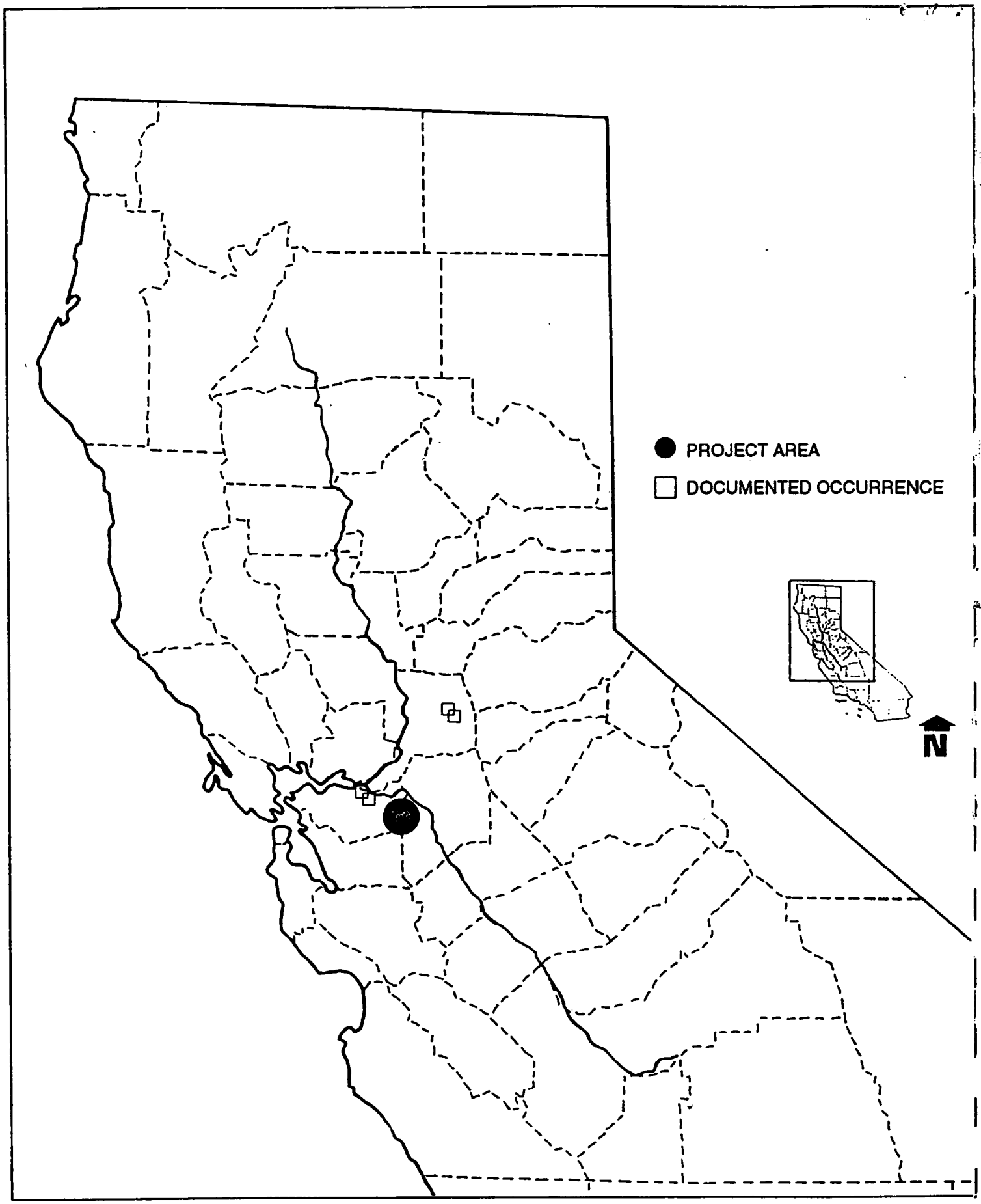
These records are indicated on the distribution map. In general, its range should be considered to extend from Carmichael (on the American River, in Sacramento County), downstream to the American River confluence with the Sacramento River, then downstream through the Delta to Antioch, Contra Costa County.

Habitat Requirements

Young (1988) reported that "many species [of *Polyphylla* are] restricted to specific, isolated, sandy environmental refugia". A description of the type-locality is not provided, however, the distribution of the species at Antioch, Contra Costa County supports the supposition that the Delta June beetle also inhabits "sandy environmental refugia"; and the majority of reports reviewed for this study indicate a sandy substrate is preferred.

No specific biology for the Delta June beetle is reported; however, biology for *Polyphylla* spp. is well-reported, as they are widely distributed agricultural pests (Cranshaw and Zimmerman 1989; Habibi 1985; Kard and Hain 1987a,b, 1988, 1990; Kard *et al.* 1988; Lily and Shorthouse 1971; Onsager *et al.* 1972; Salehi 1984, Van Steenwyk and Rough 1989, Van Steenwyk *et al.* 1990).

Polyphylla sp. adults feed on foliage, while larvae migrate through the soil, sometimes several meters laterally (Kard and Hain 1988), at depths ranging from very near the surface



Distribution of the Delta June Beetle in California

to 0.5-0.6 m (20-24 inches) (Habibi 1985, Van Steenwyk and Rough 1989). There they feed upon the roots of various plants. Life cycles may require 2 to 3 years for completion, with the majority of it spent as larval forms (three instars are known) within the soil. Kard and Hain (1988) described the life cycle typical of *Polyphylla* sp. in the cooler Appalachian mountains:

> "*... the beetle's life cycle generally lasts 3 yr, with the grub stage present for 2 yr. Grubs molt twice before burrowing into the soil to form pupal cells. In 3-4 wk, pupae transform to adults which overwinter and emerge the next spring.*"

Upon emergence, adults mate, and females oviposit the next generation of eggs into the soil.

Van Steenwyk and Rough (1989), from a recent 3-year study of *P. decemlineata* (considered a pest in almond orchards) near Manteca (San Joaquin County), reported that one generation is produced every two years, with larvae overwintering as first and third instars. Second instar larvae were rarely found between August and April. The majority of larvae are found 0.1-0.35 m (4-14 inches) deep, with first instar larvae near the surface and third instar larvae occupying the deeper end of the range. Adult emergence begins in mid-June, and continues through mid-October, with a peak in early August.

Although Lilly and Shorthouse (1971) (notably, from work in Canada) reported that both sexes of *P. decemlineata* congregated in nearby trees to mate, Van Steenwyk and Rough (1989) reported that females remained at emergence sites, where males were attracted to a sex pheromone released before female emergence. Once copulation had been completed, females returned quickly to the soil. Adult male flight, characterized as irregular and low to the ground, is reported to begin around twilight, and may continue until approximately midnight (Van Steenwyk and Rough 1989). Young (pers. comm.) reported flight activity periods of "+/- 2 hours." According to Lilly and Shorthouse (1971) flight may be influenced by temperature, cloud cover, wind velocity, and soil moisture. Van Steenwyk and Rough (1989) reported that flight was extended on warmer nights. Fowler and Whitford (1981) reported mating biology for *P. diffracta*, another member of the "*diffracta*" species-complex, into which Young (1988) placed the Delta June beetle. They report males observed between 1800 and 2000 hours, on July 26, flying in a "zig-zag" pattern 10-50 cm (4-20 inches) above the ground.

Critical Habitat

No critical habitat is defined for the Delta June beetle. However, one of only two localities known to support the species (i.e., the Antioch Dunes), is legally protected as critical habitat for the Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) and the Antioch Dunes evening-primrose (*Oenothera deltoides* ssp. *howellii*) USFWS 1980). In 1980, approximately 55 acres of the Antioch Dune system were acquired by the USFWS (USFWS 1980), and was subsequently placed in the San Francisco Bay National Wildlife Refuge

Complex (WWF 1990). These lands, along with additional acquisitions, now comprise the Antioch National Wildlife Reserve, which encompasses approximately 70 acres (WWF 1990).

Reasons for Decline

As the species is only newly-described (Young 1986), work with the Delta June beetle has been too limited to document a "decline." Distribution records (reported above) indicate the species has not been seen since 1959 at Carmichael (Sacramento County). Many species of *Polyphylla* are restricted to "specific, isolated, sandy environmental refugia" (Young 1988); Van Steenwyk and Rough (1989) postulated limited dispersal ability due to a lack of female flight and the production of only one generation every two years.

Polyphylla spp. are reported as pests upon a wide variety of crops, suggesting that they are "generalists" in terms of plant associations. The historically documented range (Carmichael, Sacramento County, to Antioch, Contra Costa County) suggests that they are capable of occupying both desert and riverine sand deposits. In either case, much available habitat has been lost to development activities such as stream channelization and land reclamation. The loss of available habitat, exacerbated by limited dispersal ability, has probably precipitated a historical decline of the species. Further, the restriction of a species to small, widely scattered locations renders individual populations vulnerable to localized disturbance.

Potential for Occurrence in the PSA

Due to the lack of suitable dune habitat, the potential for occurrence of the Delta June beetle in the ISDP area is considered unlikely. In general, the level of disturbance in the Delta may preclude the possibility of suitable habitat remaining. Despite extensive work in the area, dune habitat has not been reported, and preliminary reconnaissance surveys have identified none. Although the species may have the ability to utilize dune formations of various origins supporting various plant associations, its poor dispersal capabilities suggest that its ability to exploit recently-formed and/or temporary dune locations (e.g., dredge spoils disposal sites) and disturbed sandy habitats is minimal.

Proposed Survey Methodology

Although, occurrence in the PSA is considered unlikely, researchers conducting surveys for other sensitive species will identify and report coincidentally encountered dune habitat. It is important to note that such habitat should constitute true dune (including riverine deposits), and not recently formed and/or disturbed sandy habitat.

Should dune habitats be identified, follow-up surveys should be conducted during the probable adult activity season of July, August, and September. Many workers (Hardy 1981, Hardy and Andrews 1978, Young 1986, 1988, Van Steenwyk and Rough 1989, Kard and Hain 1990) have reported *Polyphylla* response to light traps, and Young (pers. comm.) indicated that this is virtually the only way *Polyphylla* are found. Follow-up surveys should involve light trapping at potentially-occupied sites between dusk and 2100 hours. Although reportedly relatively easy to identify due to the distinctive "speckled" appearance of the elytra, should individuals be collected, they should be identified by qualified personnel.