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DISTRIBUTION AND HABITATS OF AMPHIBIANS IN THE CENTRAL REGION OF SAUDI ARABIA

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***Abstract.*—We surveyed 80 wetland sites throughout central Saudi Arabia, a large area that has been poorly documented for amphibians. We found toads and frogs in 30 of the 80 sites, including new records for amphibians in central Saudi Arabia. We found *Duttaphrynus dhufarensis* to have a wider distribution than *D. arabicus* and *Pelophylax ridibundus.* Four habitat types in the study area were apparent: seasonal ponds formed after rain, dam reservoir, ponds formed by treated sewage water, and irrigated palm farms. Two toads, *D. dhufarensis* and *D. arabicus*, occurred primarily in irrigated palm farms and dam reservoirs. During the dry season individuals of these species hide under rocks and wood. The frog, *P. ridibundus*, occurred in irrigated palm farms and treated sewage water ponds outside cities. The distribution of these species appears to have expanded in recent decades due to increased agricultural development and habitats resulting from sewage treatment facilities**.

Key Words.— amphibians; distribution; *Duttaphrynus arabicus*; *Duttaphrynus dhufarensis*; *Pelophylax ridibundus;* Saudi Arabia.

INTRODUCTION

Saudi Arabia is inhabited by seven species of amphibians, four of which are endemic to Saudi Arabia (*Duttaphrynus arabicus*, *D. dhufarensis*, *Bufo tihamicus*, *Euphlyctus ehrenbergii*) and three of which occur elsewhere in the Palaearctic region (*Bufotes viridis*, *Hyla savignyi*, *Pelophylax ridibudus*; Balletto et al. 1985). Only three detailed studies have been conducted on the amphibians of Saudi Arabia (Balletto et al. 1985; Schätti and Gasperetti 1994; Al-Qahtani 2011). Although all Arabian amphibians are listed as Least Concern (LC) in the International Union for Conservation of Nature (IUCN) Red List 2013 (IUCN 2013), a notable decrease of amphibians' species numbers for multiple species has been observed due to drought, habitat destruction, and pollution (Al-Qahtani 2011). Balletto et al. (1985) found *D. dhufarensis*, *D. arabicus*, and *P. ridibundus* at high elevations (2,000–2,800 m) in southwestern Saudi Arabia. Balletto et al. (1985) also reported these species at lower elevation elsewhere in Saudi Arabia: *D. dhufarensis* (460 m) near Makkah in western Saudi Arabia, *D. arabicus* (556 m) in Al-Aflaj in central Saudi Arabia, and *P. ridibundus* (200 m) in Al-Hassa in eastern Saudi Arabia.

The amphibian fauna of central Saudi Arabia, which includes only *D. dhufarensis, D. arabicus, P. ridibundus,* and *E. ehrenbergii* (Balletto et al. 1985), is particularly poorly known. Central Saudi Arabia is an arid habitat; the average rainfall in Riyadh and Qassim provinces for the period from 1998−2009 was 110 and 140 mm/y, respectively (Al-Mazroui 2011). There are very few habitats with permanent fresh water bodies, such as Al-Hayr (24°30'N, 46°45'E), south of Riyadh city, and Al-Kharj water-holes (23°59'N, 47°10'E), 80 km south of Riyadh. However, new aquatic habitat has been formed by the development of irrigated agriculture, dam reservoirs, and sewage water treatment facilities around cities. The goal of the present study was to better determine the distribution and habitats of amphibians throughout central Saudi Arabia.

MATERIAL AND METHODS

Study area.—The study area was located in the middle of Saudi Arabia (Kingdom of Saudi Arabia; Fig.1). The study area covers 23.2% of the total area of the Kingdom. Most of the western part of the study area belongs to the Arabian Shield formation, while the eastern and southern regions are parts of the Arabian shelf. Sand dunes cover most of northern and southern parts of the study area (Chapman 1978). The Twaiq Mountains run from northwest to southeast from the northern part of the study area (260 km north of Riyadh) for about 985 km. The high mean summer temperature in central Saudi Arabia is 37° C and the low mean winter temperature is 8° C (Anonymous 1998).

We determined the distribution of amphibians within the study area by visiting sites during 2008 and 2009. We identified wetland sites by ground searching. We conducted amphibian surveys primarily during rainy seasons and after torrential rains, and we visited each site at least two times. We determined the exact location

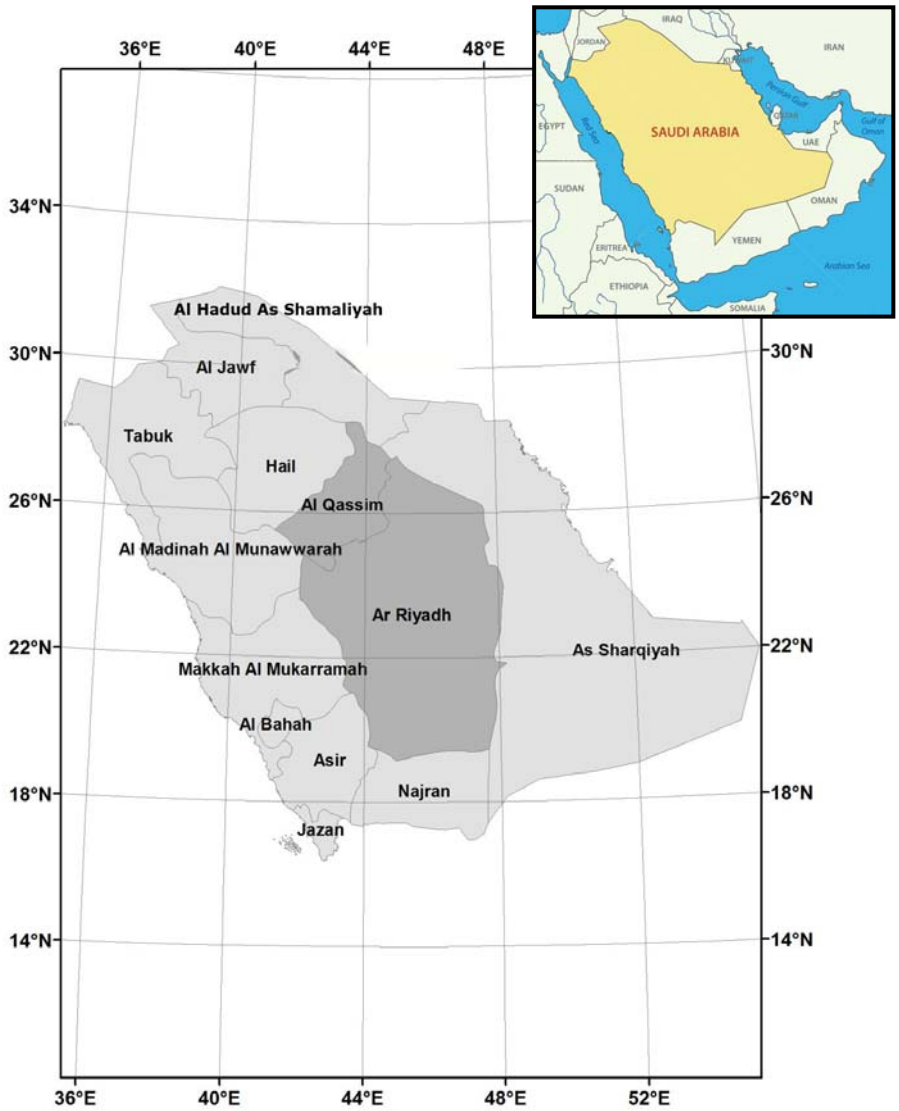

FIGURE 1. Study area, delineated by Al-Qassim and ArRiyadh provinces, within Saudi Arabia.

of each site and each amphibian found with a global positioning system (GPS) unit (Garmin International Inc., Olathe, Kansas, USA), and described the habitat. Valleys, irrigated palm farms, and dam reservoirs were travelled on foot, starting shortly after sunset using a flashlight. Once a moist area was found, we searched thoroughly for amphibians. We also searched the shoreline of dam reservoirs, and ponds made by treated sewage water in the vicinity of cities. We deposited specimens in the Zoology Department, College of Science, King Saud University. Locations for sites with and without amphibians were plotted using a geographic information systems program (ESRI Saudi Arabia Ltd, Riyadh, Kingdom of Saudi Arabia).

RESULTS

We surveyed 80 wetland locations in the study area. We defined four categories of wetlands: (1) seasonal temporary wetlands which formed after rain, such as ponds (Ain = the Arabic word for pond), and small springs in valleys (n = 10); (2) man-made wetlands, such as dam reservoirs (n = 9); (3) ponds and streams made by treated sewage water in the vicinity of major cities (n = 3); and (4) irrigated gardens and palm farms (n = 58). We found amphibians at 30 of the 80 sites (Table 1). Most of the sites with amphibians were irrigated palm

TABLE 1. Number of sites where amphibians were found and were not found among the four habitat categories in the Central Saudi Arabia study area. Details for each site are provided in Appendix 1.

Species/ Total	Seasonal wetlands	Dam reservoirs	Lagoon of treated sewage water	Irrigated farms	Total sites
D. dhufarensis	1	7	-	7	15
D. arabicus	-	-	-	5	5
P. ridibudus	-	1	3	6	10
Total sites with amphibians	1	8	3	18	30
Total sites with no amphibians	9	1	-	40	50
Total all sites	10	9	3	58	80

farms and dam reservoirs (80% of sites; 18 and 8 sites, respectively; Table 1). Only three of the sites with amphibians were in treated ponds and one was a seasonal wetland (Ain). We found three of the four amphibian species previously reported for central Saudi Arabia (Fig. 2).

Duttaphrynus dhufarensis.—Most of the 15 sites where we found *D. dhufarensis* were in the eastern part of the study area (Riyadh province), from Thadiq at 150 km north of Riyadh and southward to Al-Aflaj, which is about 300 km south of Riyadh (Fig. 1). The elevation range of these sites was 465−1031 m. The species was absent in Al-Qassim province. Almost half of the *D. dhufarensis* sites were around dam reservoirs (n = 7), another almost half were found in irrigated palm farms, and one location was a pond (Ain) in Oyainah, north of Riyadh (Table 1). During dry seasons we found *D. dhufarensis* sheltering under rocks and woods in irrigated palm farms. For example, in one location, in Ain Al-Oyainah, 50 km north of Riyadh, we did not find the species during 2008 when the Ain was dry, whereas we found a large number of the species during 2009 rainy season in the same location.

Duttaphrynus arabicus.—Observations of *D. arabicus* were restricted to five locations in the study area (Fig. 1). Unlike *D. dhufarensis*, we found the species only in irrigated palm farm areas, and found no individuals in dam reservoirs or ponds formed by treated sewage water (Table 1). This study represents the first record of the species in Al-Qassim province. The five sites with the species were: in Al-Hayr (nursery farm), south of Riyadh; two sites (irrigated farms) in Unayzah; in wheat farms which were part of a palm farm in Ar-Rass; and in an irrigated palm farm in Al-Aflaj, 300 km south of Riyadh. The elevation range of occupied sites was 556−696 m.

Pelophylax ridibundus.—The distribution of *P. ridibundus* in Central Arabia was limited to only ten locations out of 30 wetland habitats surveyed (Table 1; Fig. 2). Three locations were around Riyadh city, in Wadi Hanifa, Wadi Nemar, and Al-Hayr; one location was in Deriyah, northwest of Riyadh; one was in Oyainah; one was in Al-Kharj; three were in Al-Majmaah, 180 km north of Riyadh; and one was in treated sewage water near Unayzah city, in Al-Qassim province. We found *P. ridibundus* in irrigated farms and ponds of treated sewage water primarily (Table 1). We found one individual in a dam reservoir in Al-Majmaah located near a palm garden. The elevation range of occupied sites was 534−743 m.

DISCUSSION

The only previous records of amphibians in central Arabia were *D. dhufarensis* (Hyer), *D. arabicus* (Al-Aflaj), *P. ridibundus* (Al-Kharj), and *Euphlyctis ehrenbergii* (Riyadh), which is four of the seven species that occur in Saudi Arabia (Balletto et al. 1985). Balleto et al. 1985 recorded each of the four species in one location only in central Saudi Arabia. In the present study we did not find *E. ehrenbergii* in Riyadh or in other wetlands in central Saudi Arabia, a finding that is consistent with the idea that the species was released or escaped from King Saud University (KSU) Campus (Balletto et al. 1985).

Both *D. dhufarensis* and *D. arabicus* have a widespread distribution in Arabian Peninsula. They have been recorded in southwestern Arabian Peninsula along Hejaz, Asir mountains, and Tihamah from south of Makkah down to Yemen, and eastward to southern

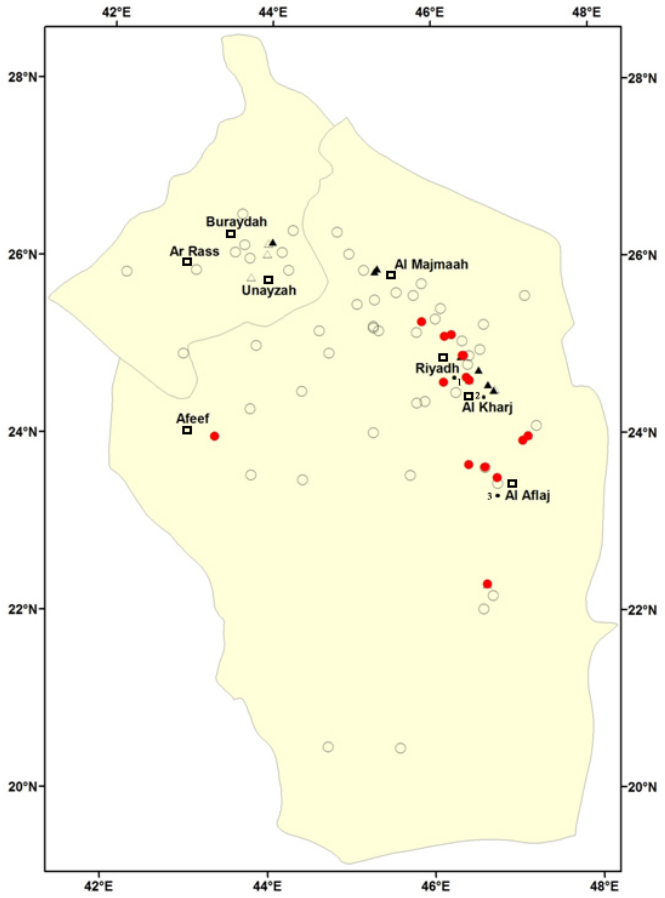

FIGURE 2. Locations of sites surveyed and where we found *Duttaphrynus dhufarensis* (●), *D. arabicus* (Δ), and *Pelophylax ridibundus* (▲) in Central Saudi Arabia. Coordinates and habitats for these locations are provided in Appendix 1. Open circles (○) are sites surveyed where amphibians were not found. Records of Balletto et al. (1985) (•) are indicated for three species as follows: 1, *D. dhufarensis*; 2, *P. ridibundus*; 3, *D. arabicus*. Cities are indicated by (□).

Oman and eastern United Arab Emirates (Balletto et al. 1985; Soorae et al. 2013). In Southern Saudi Arabia, the distributions of *D. dhufarensis* and *D. arabicus* are restricted mostly to mountainous habitat and wadis with good precipitation and sparse vegetation (Balletto et al. 1985; Schätti and Gasperetti, 1994; Al-Qahtani 2011). In the United Arab Emirates and northern Oman, Soorae et al. (2013) also found *D. dhufarensis* and *D. arabicus* restricted to wetland habitat in Hajar Mountain and valleys with heavy water flow.

In central Saudi Arabia the distributions of *D. dhufarensis* and *D. arabicus* appear to be restricted to wet habitats, mainly irrigated gardens and dam reservoirs, and toads are absent from treated sewage water ponds. All locations surveyed in the present study are below 800 m elevation (except Afeef, 1031 m).

The distribution map shows a relatively wide distribution of *D. dhufarensis* in central Saudi Arabia in comparison to *D. arabicus*. *Duttaphrynus dhufarensis* also inhabits more diverse habitats than *D. arabicus*, having been found in three of the four habitat categories in the present study. *Duttaphrynus arabicus* was not recorded far from wet habitats with permanent water year round such as irrigated farms. The wider distribution and greater habitat diversity of *D. dhufarensis* compared to the *D. arabicus* may indicate it is more tolerant to harsher environmental conditions (Soorae et al. 2013).

Toads are able to survive prolonged drought by aestivation (Balletto et al. 1985; Soorae et al. 2013). We found *D. dhufarensis* about 15 cm below surface of the dry bed of Deriyah dam reservoir, northwest of Riyadh, which was found by digging in the soil. Balletto et al. (1985) also found *D. dhufarensis* in burrows up to 30 cm deep in Wadi Hadramawt, south of Yemen. During 2008 Ain Al-Oyanah, 50 km north of Riyadh, was completely dry and no toads were found. In 2009, it was full of *D. dhufarensis* after heavy rain. A similar phenomenon was reported by Balletto et al. (1985) in a basin in Makkah by-bass, west of Saudi Arabia, which indicates the species' ability to aestivate.

Pelophylax ridibundus has a limited distribution in central Saudi Arabia; we found it only in well-watered habitats, such as treated sewage water ponds and irrigation ditches of date palm farms. Previous records

of *P. ridibundus* in Arabian Peninsula were from eastern populations in Bahrain, Al-Qatif, and Al-Hasa, and a southwestern population in Asir (Briggs 1981; Balletto et al. 1985). Al-Qahtani (2011) reported *P. ridibundus* in Abha area, Baha, and Namas, southwest of Saudi Arabia. Balletto et al. (1985) suspected the presence of *P. ridibundus* in Al-Kharj, 80 km south of Riyadh, as recently introduced. The presence of *P. ridibundus* in Al-Majmaah and Al-Qassim are the first records of the species in these provinces.

Balletto et al. (1985) found all three species (*D. dhufarensis*, *D. arabicus*, and *P. ridibundus*) at high elevations in southwestern Saudi Arabia, which may indicate that the three species are high-elevation specialists in this region. The present study, however, shows that *D. dhufarensis*, *D. arabicus*, and *P. ridibundus* occur at lower elevations in central Saudi Arabia (465−1031 m, 556–696 m, and 534–743 m, respectively). Briggs (1981) and Balletto et al. (1985) also reported *P. ridibundus* from Al-Qatif (5–60 m) in eastern Saudi Arabia and Bahrain. The differences in elevation ranges between southwestern and eastern Saudi Arabia for the three species may be explained by Balletto et al.'s (1985) suggestion that the amphibian populations in the southwestern portion of the Arabian Penninsula represent Palaearctic relicts whereas the eastern amphibian populations are relicts from a western Asian invasion.

The main Karst lakes in Al-Kharj and in Al-Aflaj dried out more than three decades ago; previously, these lakes formed suitable wetland habitats for amphibians (Tinley 1994). The distributions of the three species found in the present study in central Saudi Arabia seem to be more extensive than known from previous studies such as Balletto et al. (1985), suggesting that the distributions have expanded in recent decades. Two reasons likely explain this situation. First, agricultural development has increased (Soorae et al. 2013), especially traditional palm farms, which depend on large collecting reservoirs and rivulets for water distribution in the farm. Second, ponds and streams of treated sewage water have formed outside major cities. For example, Riyadh ponds and watercourses that formed by treated sewage water and rain floodwater from the city have become a haven for more than 300 species of birds (Stagg 1994). Freshwater fishes, at least three species of amphibians, many reptile species, and insect life thrive in these wet habitats. Similar wetlands have formed outside other major cities in the Kingdom. Unfortunately, the above two sources of wetland habitat for amphibians may change in near future. Most farms in the Kingdom are shifting to drip irrigation for water conservation, which means less suitable amphibian habitats such as pools and rivulets. Also, the treated sewage water authority is planning for tertiary treatment, and water will be piped to farms rather than pumped outside cities. Polluted freshwater habitats caused by the huge amounts of pesticides used to control malaria, especially in the southwestern region of the Kingdom, could be added to possible reasons for amphibian declines (Al-Qahtani 2011). Other possible threats to amphibians, such as the Amphibian Chytrid fungus (*Batrachochytrium dendrobatidis*), should be further investigated (Soorae et al. 2012).

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APPENDIX 1. Coordinates, species found, and habitat categories of the 80 study sites.

No.	Coordinates		Species Found	Habitat Categories
1	N25°08'	E46°14'	*D. dhufarensis*	Dam reservoir
2	N25°07'	E46°09'	*D. dhufarensis*	Dam reservoir
3	N23°31'	E46°47'	*D. dhufarensis*	Dam reservoir
4	N23°40'	E46°26'	*D. dhufarensis*	Dam reservoir
5	N23°56'	E47°06'	*D. dhufarensis*	Irrigated palm farm
6	N23°38'	E46°38'	*D. dhufarensis*	Irrigated palm farm
7	N24°54'	E46°23'	*D. dhufarensis*	Irrigated palm farm
8	N24°54'	E46°22'	*D. dhufarensis*	Seasonal wetland
9	N24°37'	E46°27'	*D. dhufarensis*	Dam reservoir
10	N24°39'	E46°25'	*D. dhufarensis*	Dam reservoir
11	N23°59'	E47°10'	*D. dhufarensis*	Irrigated palm farm
12	N22°19'	E46°39'	*D. dhufarensis*	Irrigated palm farm
13	N24°36'	E46°08'	*D. dhufarensis*	Irrigated palm farm
14	N25°17'	E45°52'	*D. dhufarensis*	Irrigated palm farm
15	N23°59'	E43°19'	*D. dhufarensis*	Dam reservoir
16	N22°19'	E46°39'	*D. arabicus*	Irrigated palm farm
17	N24°31'	E46°46'	*D. arabicus*	Irrigated palm farm
18	N25°47'	E43°45'	*D. arabicus*	Irrigated palm farm
19	N26°03'	E43°57'	*D. arabicus*	Irrigated palm farm
20	N26°10'	E43°58'	*D. arabicus*	Irrigated palm farm
21	N25°53'	E45°19'	*P. ridibudus*	Irrigated palm farm
22	N25°51'	E45°17'	*P. ridibudus*	Dam reservoir
23	N25°52'	E45°20'	*P. ridibudus*	Irrigated palm farm
24	N24°30'	E46°45'	*P. ridibudus*	Pond of sewage water
25	N24°44'	E46°34'	*P. ridibudus*	Irrigated palm farm
26	N24°53'	E46°21'	*P. ridibudus*	Irrigated palm farm
27	N24°34'	E46°41'	*P. ridibudus*	Irrigated palm farm
28	N24°37'	E46°27'	*P. ridibudus*	Pond of sewage water
29	N23°59'	E47°10'	*P. ridibudus*	Irrigated palm farm
30	N26°11'	E44°01'	*P. ridibudus*	Pond of sewage water
31	N25°14'	E45°16'	---	Irrigated palm farm
32	N25°20'	E45°11'	---	Irrigated palm farm
33	N25°17'	E45°32'	---	Irrigated palm farm
34	N25°04'	E45°29'	---	Irrigated palm farm
35	N24°18'	E43°45'	---	Irrigated palm farm
36	N23°55'	E42°55'	---	Irrigated palm farm
37	N24°30'	E44°23'	---	Irrigated palm farm
38	N25°35'	E45°46'	---	Irrigated palm farm
39	N25°37'	E45°33'	---	Irrigated palm farm
40	N25°10'	E45°48'	---	Irrigated palm farm
41	N26°03'	E44°58'	---	Irrigated palm farm
42	N26°18'	E44°49'	---	Irrigated palm farm
43	N24°02'	E45°16'	---	Dam reservoir
44	N24°29'	E46°17'	---	Irrigated palm farm
45	N24°22'	E45°48'	---	Irrigated palm farm
46	N24°23'	E45°54'	---	Irrigated palm farm
47	N25°34'	E47°09'	---	Irrigated palm farm
48	N25°04'	E46°22'	---	Irrigated palm farm
49	N24°54'	E46°27'	---	Irrigated palm farm
50	N24°06'	E47°16'	---	Seasonal wetland
51	N25°52'	E45°09'	---	Irrigated palm farm
52	N23°30'	E44°24'	---	Seasonal wetland
53	N23°33'	E43°46'	---	Seasonal wetland
54	N22°43'	E42°10'	---	Seasonal wetland
55	N20°29'	E44°43'	---	Irrigated palm farm

56	N20°28'	E45°35'	---	Irrigated palm farm
57	N25°11'	E44°36'	---	Irrigated palm farm
58	N22°02'	E46°36'	---	Seasonal wetland
59	N23°38'	E46°38'	---	Irrigated palm farm
60	N23°27'	E46°47'	---	Irrigated palm farm
61	N25°01'	E43°49'	---	Irrigated palm farm
62	N24°56'	E44°43'	---	Irrigated palm farm
63	N23°33'	E45°32'	---	Irrigated palm farm
64	N25°19'	E46°02'	---	Irrigated palm farm
65	N24°58'	E46°35'	---	Seasonal wetland
66	N25°26'	E46°06'	---	Seasonal wetland
67	N25°13'	E45°16'	---	Irrigated palm farm
68	N25°15'	E46°38'	---	Irrigated palm farm
69	N24°48'	E46°26'	---	Irrigated palm farm
70	N25°43'	E45°52'	---	Irrigated palm farm
71	N22°11'	E46°43'	---	Seasonal wetland
72	N26°09'	E43°40'	---	Irrigated palm farm
73	N25°52'	E44°13'	---	Irrigated palm farm
74	N26°00'	E43°44'	---	Irrigated palm farm
75	N26°19'	E44°16'	---	Irrigated palm farm
76	N26°04'	E43°33'	---	Irrigated palm farm
77	N25°52'	E43°04'	---	Irrigated palm farm
78	N26°04'	E44°08'	---	Seasonal wetland
79	N26°30'	E43°38'	---	Irrigated palm farm
80	N25°50'	E42°12'	---	Irrigated palm farm