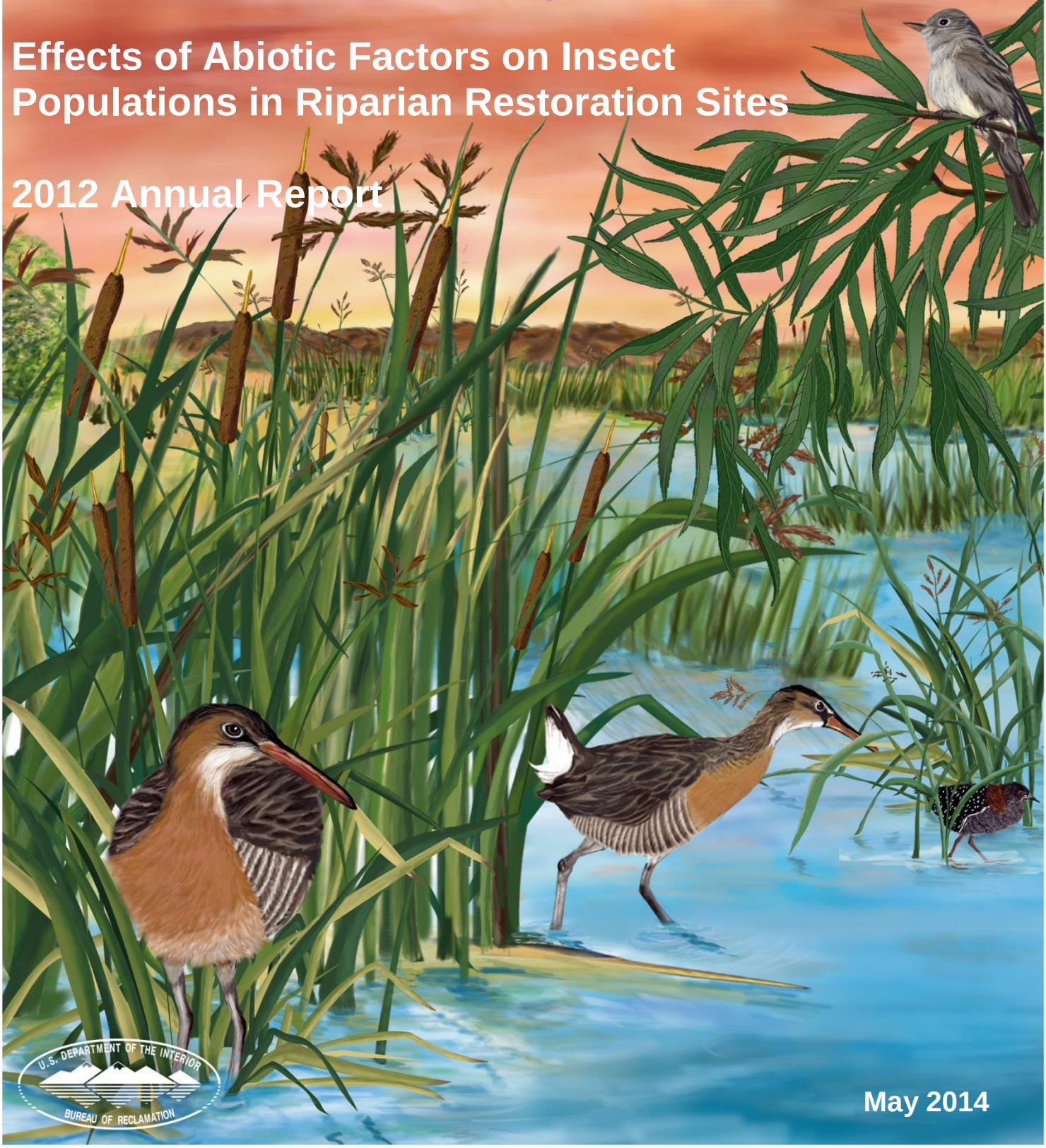
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Effects of Abiotic Factors on Insect Populations in Riparian Restoration Sites

2012 Annual Report



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Lower Colorado River
Multi-Species Conservation Program

Effects of Abiotic Factors on Insect Populations in Riparian Restoration Sites

2012 Annual Report

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ACRONYMS AND ABBREVIATIONS

ADP	adenosine diphosphate
AMP	adenosine monophosphate
ATP	adenosine triphosphate
BLCA	Beal Lake Conservation Area
DNA	deoxyribonucleic acid
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
P	phosphorus
RNA	ribonucleic acid

Symbols

%	percent

CONTENTS

Page

Abstract iii

Introduction 1
Methods 1
Spider and Insect Collections and Identifications 1
Measuring Phosphorus Concentrations 2
Results 3
Discussion 8
Literature Cited 11

Tables

Table — Page

1 Spiders and insects collected from riparian plants at the Beal Lake Conservation Area and analyzed for phosphorus content 4

Figures

Figure — Page

1 Spiders and insects were collected from these arrowweed shrubs (foreground) and Goodding's willow trees (behind) at the Beal Lake Conservation Area within the Havasu National Wildlife Refuge. 2
2 Spiders and insects also were collected from these cottonwood trees at the Beal Lake Conservation Area. 3
3 Abundances of spiders and insects collected on different plant species and in a Malaise trap at the Beal Lake Conservation Area during 2012. 5
4 *Melanoplus herbaceous*, a 2.5-centimeter-long grasshopper found only on arrowweed, a native plant. 6
5 A rough stinkbug (*Brochymena sulcata*) swept from a cottonwood tree. These insects are both plant feeding and predaceous 6
6 A *Tabanus* deer fly caught in the Malaise trap. Females suck blood, including human blood, whereas males eat pollen and nectar. 7

Figures

Figure		Page
7	A *Polistes* wasp caught in the Malaise trap. *Polistes* wasps, called paper wasps, construct nests from saliva and ingested dead wood.	7
8	Phosphorus mass versus body dry mass of spiders and insects collected at the Beal Lake Conservation Area (axes are log scales).	8

ABSTRACT

Phosphorus is a nutrient in spiders and insects that may be important to insectivorous birds. Phosphorus is found in deoxyribonucleic acid (DNA), ribonucleic acid (RNA), adenosine triphosphate (ATP), and other adenine nucleotides, phosphorylated metabolites, and phospholipids. Masses and concentrations of phosphorus were measured in 3 families of spiders and 24 families of insects collected at the Beal Lake Conservation Area during 2012. Concentrations of phosphorus (P mass per body dry mass) were greater in spiders (1.4 percent [%]) than in insects (1.0%). Phosphorus concentrations also were higher in insect predators (1.0%) than in insect herbivores (0.9%). Spiders and predatory insects may be preferentially eaten by insectivorous birds for their phosphorus content. It is recommended that insects be considered during the selection of plant species for restoration sites. Habitat that sustains a diversityof insects and spiders will help support a prey base for Lower Colorado River Multi-Species Conservation Program covered species and provide an assortment of nutrients needed by insectivorous birds and other wildlife.

INTRODUCTION

Eight species of birds (southwestern willow flycatcher, yellow-billed cuckoo, gilded flicker, Gila woodpecker, vermilion flycatcher, Bell's vireo, Sonoran yellow warbler, and summer tanager) and four species of bats (western red bat, western yellow bat, California leaf-nosed bat, and pale Townsend's big-eared bat) included in the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) eat arthropods (spiders and insects). Arthropods eaten by the southwestern willow flycatcher were documented by Wiesenborn and Heydon (2007). Creating and maintaining habitat for these species will require providing an adequate supply and diversity of arthropods for food. This is a concern at several LCR MSCP habitat creation sites being developed because riparian vegetation is being planted in non-riparian farmland (i.e., where water tables are lowered, soil salinities are elevated, and spring floodflows are absent). Growing plants will not by itself guarantee producing populations of spiders and insects diverse and abundant enough to feed and support bird and bat populations. Several elements, including nitrogen, sulfur, and phosphorous, are essential elements in plants and animals. These elements in plants may affect the abundance of plant-feeding insects, and in insects, they may affect the abundance of insectivorous birds.

In 2009, a variation in nitrogen content was studied among riparian spiders and insects collected at the Beal Lake Conservation Area (BLCA) (Bureau of Reclamation [Reclamation] 2012; Wiesenborn 2011a). In 2010, the abundance of resilin, an external high-nitrogen protein digestible by birds, was examined on insects (Reclamation 2013; Wiesenborn 2011b). In 2011, concentrations of sulfur were studied in insects at the BLCA (Reclamation 2014; Wiesenborn 2014). The objective during 2012 was to examine the variation in phosphorus content among spiders and insects collected at this conservation area.

METHODS

Spider and Insect Collections and Identifications

Insects were collected from planted riparian trees and shrubs at the BLCA (figures 1 and 2) within the Havasu National Wildlife Refuge. Arthropods were swept from plants and insects trapped with a Malaise trap. Spiders and insects were collected from planted cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), honey or screwbean mesquite (*Prosopis* spp.) trees, planted narrow-leaved willow (*Salix exigua*) shrubs, and voluntary arrowweed (*Pluchea sericea*) plants. Arthropods were also swept from nearby salt cedar. The collection of arthropods occurred on nine dates: April 30, May 16 and 29, June 12 and 25, July 9 and 23, and August 6 and 20, 2012. All sampled plants were in flower or fruit except for cottonwood. The Malaise trap was located in the center of a plot supporting Goodding's willow and arrowweed. Insects were

Figure 1.—Spiders and insects were collected from these arrowweed shrubs (foreground) and Goodding's willow trees (behind) at the Beal Lake Conservation Area within the Havasu National Wildlife Refuge.

trapped for 45–90 minutes during 0930–1200 Mountain Standard Time on the same nine dates. Spiders and insects were identified at least to genus and typically to species. Insects were keyed, or matched against specimens previously collected and identified (Reclamation 2012, 2013, 2014), and verified with specimens at the Entomology Research and Teaching Museum of Entomology, University of California, Riverside.

Measuring Phosphorus Concentrations

Spiders and insects were dried for 2 hours at 95 degrees Celsius, weighed with a microbalance (Cahn C-30), and digested in nitric acid within a microwave bomb (Parr, Inc.). Phosphorus concentrations were measured against adenosine monophosphate standards (AMP) (8.9 percent [%] phosphorus) with an inductively coupled plasma spectrophotometer at Reclamation's Regional Laboratory in Boulder City, Nevada. This type of spectrophotometer measures light emissions from different elements, including phosphorus. The methods are further described in Wiesenborn (2013).

Figure 2.—Spiders and insects also were collected from these cottonwood trees at the Beal Lake Conservation Area.

Phosphorus concentrations in digested spiders and insects were converted to phosphorus mass. The percent phosphorus of spiders and insects was calculated from arthropod dry mass.

RESULTS

Fourteen samples of 16 spiders in 3 families and 4 genera and 132 samples of 467 insects in 7 orders, 24 families, and 25 genera were collected (table 1). The most abundant spiders collected were crab spiders in *Mecaphesa*. Spiders were found on five of the six plant species. The most abundant insects collected were *Coniatus splendidulus*, weevils recently discovered on tamarisk (*Tamarix ramosissima*) in the United States.

Table 1.—Spiders and insects collected from riparian plants at the Beal Lake Conservation Area and analyzed for phosphorus content

Order (common name)	Family	Genus	Source[a]	Mean % phosphorus
Araneae (spiders)	Philodromidae	*Philodromus*	F, G	1.5
	Thomisidae	*Mecaphesa*	E, G, P, S	1.3
	Salticidae	*Habronattus*	E, S	1.4
		Sassacus	F	1.2
Odonata (dragonflies)	Libellulidae	*Pachydiplax*	S	1.0
Orthoptera (grasshoppers)	Acrididae	*Melanoplus*	S	1.1
	Tettigoniidae	*Insara*	S	0.9
	Mantidae	–	E, F, T, S	1.1
Hemiptera (treehoppers, true bugs, leafhoppers)	Pentatomidae	*Brochymena*	P, S	0.8
	Reduviidae	*Zelus*	E, F, S	1.1
		Phymata	E, S	0.7
	Membracidae	*Stictopelta*	P	0.7
		Tylocentrus	P	1.0
	Cicadellidae	*Acusana*	E, G	1.1
		Homalodisca	E, S	1.6
	Cixiidae	*Oecleus*	F, G	1.1
Neuroptera (lacewings)	Chrysopidae	–	E, F, P, S	1.1
Coleoptera (beetles)	Coccinellidae	*Chilocorus*	F	0.9
	Chrysomelidae	*Algarobius*	E, F, P, S	0.7
	Curculionidae	*Coniatus*	T	0.6
Diptera (flies)	Tabanidae	*Tabanus*	F, G, M	1.4
	Dolichopodidae	*Asyndetus*	M	1.4
	Tephritidae	*Acinia*	F, G	0.8
	Lauxaniidae	*Minettia*	F, G, P, S	1.1
	Tachinidae	*Zaira*	M	0.9
Hymenoptera (ants, wasps, bees)	Formicidae	*Formica*	E, F, G, P, S	1.1
	Tiphiidae	*Myzinum*	S	0.7
	Vespidae	*Polistes*	M, P, T	0.8
	Halictidae	*Dieunomia*	S	1.1
	Andrenidae	*Perdita*	S	1.0
	Apidae	*Apis*	E, S	1.2

[a] E = *Salix exigu,* F = *Populus fremonti*; G = *Salix gooddingi,* M = Malaise trap, P = *Prosopis glandulosa* or *P. pubescens*, S = *Pluchea sericea*, and T = *Tamarix ramosissima*.

The abundance and diversity of spiders and insects differed among plant species and in the Malaise trap (figure 3). Arrowweed supported the greatest arthropod abundance and diversity. Spiders were most abundant on arrowweed and coyote willow (*S. exigua*), bees and wasps were most abundant on arrowweed and the mesquites, flies were mostly caught in the Malaise trap, and insects on tamarisk were dominated by the weevil *C. splendidulus*.

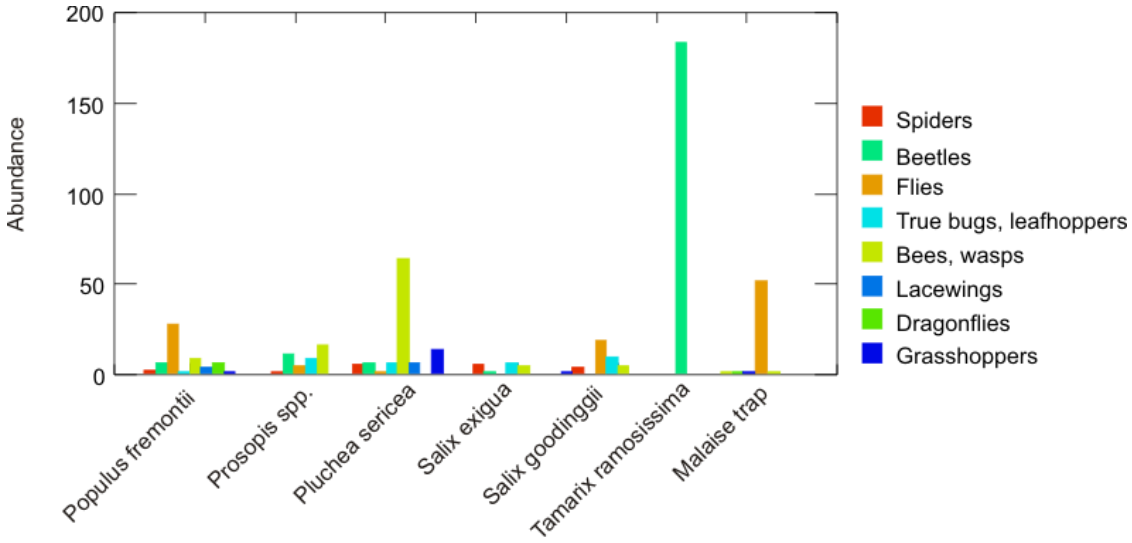

Figure 3.—Abundances of spiders and insects collected on different plant species and in a Malaise trap at the Beal Lake Conservation Area during 2012.

Collected insects included a grasshopper (*Melanoplus herbaceous*) (figure 4), specific to arrowweed; a large pentatomid bug (*Brochymena sulcata*) (figure 5) found on mesquite and cottonwood trees; a colorful wood-boring beetle (*Acmaeodera gibbula*) swept from mesquite; *Tabanus* deer flies (figure 6), and *Polistes* paper wasps (figure 7) collected in the Malaise trap. All insects collected were adults except for *M. herbaceous*, mantids, and *B. sulcata*.

Body dry mass of spiders and insects ranged from 0.3 milligram in the dolichopodid fly *Asyndetus* to 80 milligrams in the katydid *Insara elegans*. A linear relationship was found between phosphorus mass and body dry mass (figure 8).

Phosphorus contents varied among taxa of arthropods (see table 1). Phosphorus concentrations (P mass per body dry mass) were greater in spiders (1.4%) than in insects (1.0%). Phosphorus concentrations also were higher in insect predators (1.0%) than in insect herbivores (0.9%). Additional descriptions of the results can be found in Wiesenborn (2013).

Figure 4.—*Melanoplus herbaceous*, a 2.5-centimeter-long grasshopper found only on arrowweed, a native plant.

Figure 5.—A rough stinkbug (*Brochymena sulcata*) swept from a cottonwood tree. These insects are both plant feeding and predaceous.

Figure 6.—A *Tabanus* deer fly caught in the Malaise trap. Females suck blood, including human blood, whereas males eat pollen and nectar.

Figure 7.—A *Polistes* wasp caught in the Malaise trap. *Polistes* wasps, called paper wasps, construct nests from saliva and ingested dead wood.

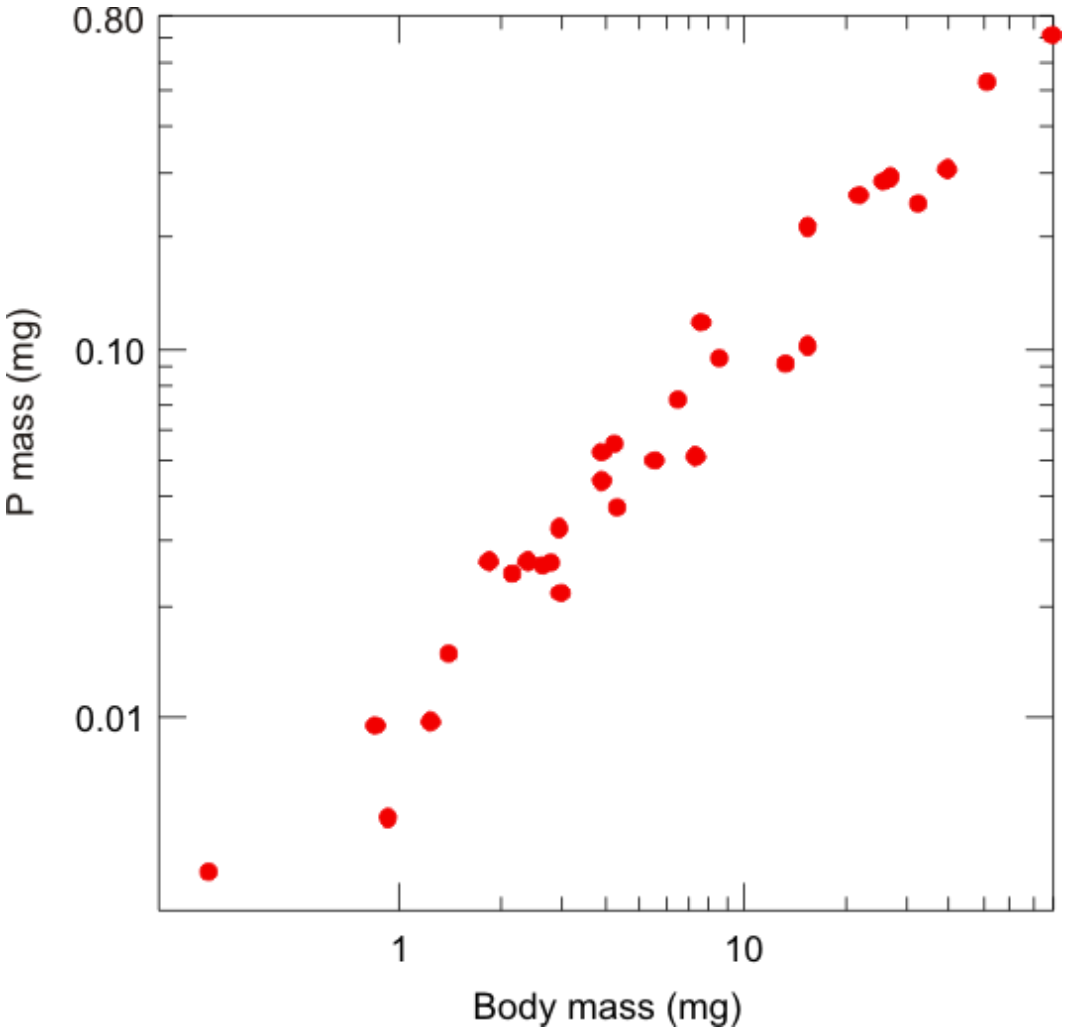

Figure 8.—Phosphorus mass versus body dry mass of spiders and insects collected at the Beal Lake Conservation Area (axes are log scales).

DISCUSSION

The relationship between phosphorus mass and body mass in spiders and insects differed from that between nitrogen mass and body mass. Nitrogen mass increased exponentially (allometrically) with body mass (Reclamation 2012), whereas phosphorus mass increased linearly. Larger spiders and insects contain greater concentrations of nitrogen but not phosphorus.

Phosphorus is more abundant in spiders than in insects. The greater phosphorus concentration found in spiders likely resulted from higher amounts of phosphorus-containing compounds found in their venom. Venom produced by juvenile and

adult spiders contains phosphoric acid and the adenine nucleotides adenosine monophosphate (AMP), adenosine diphosphate (ADP), and adenosine triphosphate (ATP).

Arrowweed produces an abundant and diverse food base of arthropods for insectivorous birds. Some insects, such as *M. herbaceous*, are specific to the plant. Irrigation at the BLCA raises the water content of arrowweed growing at the edge of the plots and increases abundances of arthropods developing on the plant. Tamarisk supported a large abundance but a low diversity of spiders and insects. Most insects were *C. splendidulus* weevils that are specific to salt cedar.

Insectivorous birds at the BLCA may preferentially feed on spiders for their greater phosphorus contents. Spiders comprised around 7% of the prey items eaten by southwestern willow flycatchers in different habitats (Wiesenborn and Heydon 2007). However, spiders are predators dependent on lower trophic levels for food. Observations at the Palo Verde Restoration Site documented that the abundances of spiders increased later than insects during the growing season (i.e., summer rather than spring) (Reclamation 2010). The availability of spiders during the spring nesting season may be critical for successful reproduction by insectivorous birds, including the southwestern will flycatcher. Spiders may be desired as food for both parent and nestling birds.

The greater phosphorus concentrations in predaceous, compared with herbivorous, insects stresses the importance of establishing a diverse food chain that can support large populations of predatory insects (and spiders) at restoration sites.

It is recommended that insects be considered during the the selection of plant species for restoration sites. Habitat that sustains a diversityof insects and spiders will help support a prey base for LCR MSCP covered species and provide an assortment of nutrients needed by insectivorous birds and other wildlife.

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