Analysis of Barn Owl (*Tyto alba*) Diet at CSU Channel Islands and Their Potential to Control Rodents Within an Integrated Pest Management Program

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Introduction

We analyzed the barn owl (*Tyto alba*) diet on the campus of California State University Channel Islands (CSUCI) and explored the potential use of *Tyto* for the control of rodents. Owl-based Integrated Pest Management (IPM) is an alternative method to the wide-spread application of second-generation anticoagulant rodenticide (SGAR). Anticoagulants poisons work by reducing the ability of rodents to produce Vitamin K, a crucial enzyme that allows blood to clot and prevent the uncontrollable loss of blood. SAGAR have a high potential to kill non-target wildlife. We posit a more sustainable approach to rodent control at CSUCI would be to increase *Tyto* populations and therefore the corresponding predation pressure upon local rodents, ultimately reducing the numbers of potentially nuisance rodents and need for SGAR.

Powerful and efficient rodent control poisons were developed for the protection of endemic species on islands in the 1980's (Hoare and Hare 2006). These poisons soon became popular on the mainland across urban and agricultural sectors owing to widespread resistance to first-generation rodenticide (warfarin, pindone, diphacinone and clorophacinone). The more popular SGARs (bromadiolone and brodifacoum) are potent enough that a rodent need only feed on the bait once to receive an effective dose. In practice, more than one feeding event occurs; as baiting events are usually long-term or permanent.

Recently developed SGAR wildlife sampling methods have shown a wide distribution of these poisons across a range of non-target taxa. Anticoagulant rodenticide has been documented in birds of prey, small and medium-sized mammals such as American badgers (*Taxidea taxus*), Pacific fishers (*Martes pennanti*) and San Joaquin kit foxes (*Vulpes velox macrotis)*; McMillin *et al*. 2008, Thomas *et al*. 2011, Quinn *et al*. 2012). High SGAR concentrations in southern California bobcats (*Lynx rufus*) are positively correlated with severe notoedric mange (an ectoparasite). Beginning in 2002, this notoedric mange became the leading cause of death for bobcats in Ventura and Los Angeles Counties. Southern California mountain lions (*Pumas concolor*) have also been found with severe cases of notoedric mange, presumably due to secondary-anticoagulant exposure. Both felids' exposures were closely associated with increased use of SGAR in suburban and exurban areas (Riley *et al*. 2007). This evidence shows that these toxins have a large potential to move into and influence food chains well beyond their intended targets. As the CSUCI lies within the wildlife-rich Santa Monica Mountains National Recreational Area and currently using SGAR as our primary rodent control tool, we have been to (some degree) contributing to such non-target impacts.

For CSUCI to fully to commit to an alternative approach to pest management, we must show that such a program has a reasonable chance of succeeding. While IPMs that include enhancing *Tyto* nesting have successfully been used to control rodents in agricultural fields and suburban housing developments (Hafidzi and Saayon 2001, Na'im 2003, Tillmann 2012), none have been implemented in as diverse a landscape as our CSUCI campus (including, restaurants, riparian corridors, multi-storied buildings, power plants, dense housing units, orchards, *etc*.). Hence, our initial study focused on the biological aspect of an alternative IPM, beginning with an analysis of prey items of *Tyto* currently residing on our CSUCI campus. *Tyto* are ideal candidates to reduce rodent populations given that 1) nocturnal rodents are their preferred prey and 2) at times *Tyto* can overharvest (*i.e.* hunt more than they can eat) prey, and 3) *Tyto* are highly tolerant of human disturbance/landscapes (hence their eponym *barn* owls). *Tyto* are secondary cavity nesters typically using old abandon nests, tree cavities, palm trees or human structures to reproduce in southern California. Should we find a significant potential of *Tyto* to reduce rodents on campus, erecting artificial nest boxes for *Tyto* around campus would be an ideal way to increase their populations in focal campus regions.

Hypothesis:* Tyto *prey varies across roosting sites on our CSUCI campus.

Methods

The diet of *Tyto* was assessed via regurgitated pellets collected below three *Tyto* roost sites on and one roost site immediately off of the CSUCI campus. All owl pellet collection sites were below roost in pineapple palm trees (*Phoenix canariensis*). The *Aliso Palm* roosts (1 & 2) are in the campus core between two small parking lots and near the center of a main thoroughfare (Ventura Street). *Entrance Palm* roost is on the northern edge of the campus core proximate to an ephemeral riparian corridor (the just-restored Long Grade Creek) and expansive, recently-abandoned agricultural fields. *Lewis Palm* roost is located off campus on South Lewis Road that bisects intense row crop and hoop house agricultural on the Oxnard Plain (see map). As of February 14th 2013, 1,328 pellets have been collected from these four sites, however we here present data from only the first 75 dissected pellets (collected between Summer of 2011 and May of 2012).

Owl pellets were placed into plastic ziplock bags in the field, transported to the lab and frozen for 5-7 days, and then air dried for several weeks in a laboratory hood to kill potential infectious agents. Photographs, an identification number, collection site, date, weight, length and width for each pellet was recorded prior to dissection. Pellets were then soaked for a minimum of 15 minutes in 95% ethanol alcohol and then water to further sterilize and facilitate bones-fur separation during dissection. All bones and insect parts were weighed after extraction from each pellet. Rodents were identified via skulls and mandibles (jaws), birds via skulls, and insects via cephalothoraxes (jaw-like appendages).

I compared per pellet prey number and richness between sites with one-way ANOVA followed by Tukey *post hocs* when significant.

Results

We documented a total of eight mammals (*Microtus californicus, Neotoma bryanti, Neotoma macrotus, Reithrodontomys megalotis, Thomomys bottae, Chaetodipus californicus, Rattus rattus,* and unknown juvenile rabbits either a *Sylvilagus* sp. or *Lepus* sp.), at least three bird (*Junco hyemalis, Zonotrichia leucophrys, Carpodacus purpureus*) and one insect (Jerusalem cricket, *Stenopelmatus* spp.) species (Table 1, includes common names).

Tyto diets varied between roosting sites. Entrance Palm (n=23) harbored the most species per pellet at 1.52 ± 0.593 species (mean ± 1 SD). Aliso Palm 1 (n=26, 1.31 ± 0.549) and Aliso Palm 2 (n=16, 1.06 ± 0.250) showed an intermediary and Lewis Palm the lowest (n=10, 0.90 ± 0.568) richness. Roost richness differed significantly (F=4.97, d.f.= 3, p=0.007), driven by Entrance-Lewis contrasts.

As with richness, the overall prey items per pellet was greatest at the Entrance Palm (2.91±1.81 items), followed by Aliso Palm 1 (2.04 ± 1.51), Lewis Palm (1.70 ± 1.64), and Aliso Palm 2 (1.13 ± 0.81)., and Lewis Palms (1.70 ± 1.64). Prey items differed significantly between roosts (F=4.661, d.f.=3, p=0.005), with Aliso 2-Entrance contrasts driving that difference.

Discussion

Entrance Palm pellets showed significantly more prey items and species per pellet relative to other roosts. This abundance and breadth of prey may have been driven by the adjacent fallow agricultural field affording more absolute "huntable area", field being higher quality foraging habitat, or by owls having access to a greater diversity of foraging ground (edge of campus core plus the abandoned agricultural field). Independent of the drivers, our confirmed absolute numbers and breadth of prey on campus shows that CSUCI campus may be able to support a larger *Tyto* population than currently exists. This documented variety of *Tyto* prey shows their potential to control undesired rodents on CSUCI through a well-rounded IPM.

We respectfully suggest that our results be considered as CSUCI and other land managers evaluate alternative IPM plans that offer the chance to minimize the exposure to nearby wildlife to rodenticide. At a minimum, alternatives such as barn owl population increases should be considered as a serious alternative to traditional, poison-centric pest management approaches. It is also possible that an owl-centric IPM program on CSUCI campus could potentially save money and labor while also bolstering an atmosphere of active, sustainability-focused projects across campus.

We are continuing to expand our research by collecting and analyzing more pellets, searching for more roosting sites, and have recently erected our first trial nest boxes in both the core and periphery of campus to explore our ability to establish new owl roost sites on campus.

Figure 1. Sampling locations across CSUCI in Ventura County, CA.

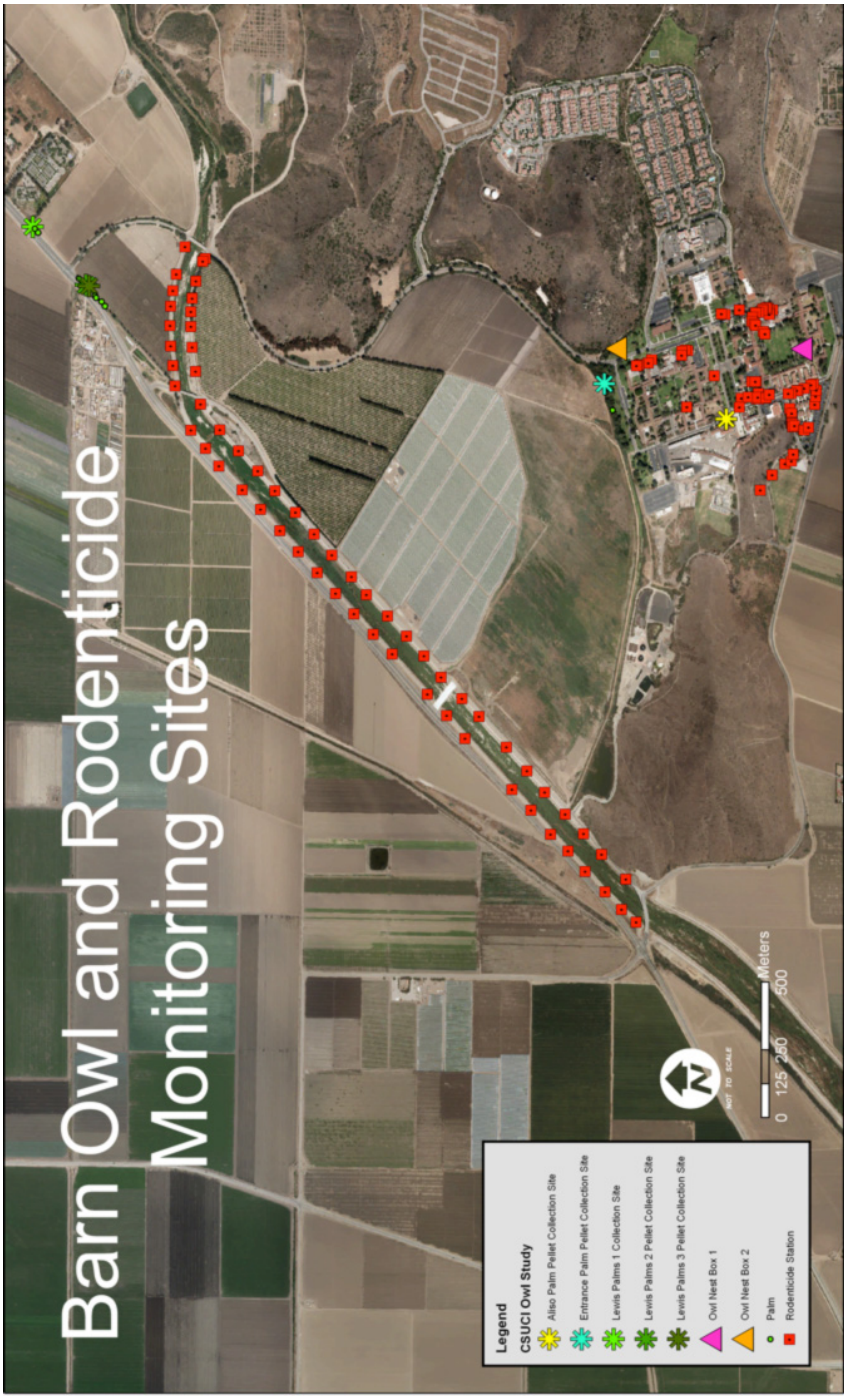

Table 1. Prey items identified from *Tyto alba* pellet.

roost	location	Mammals Rodents Cricetidae				Geomyidae	Heteromyidae	Muridae	Lagomorphs Leporidae	Birds Passerines Emberizidae		Fringillidae	Insects Orthopterans Stenopelmatidae
		Microtus californicus	*Neotoma bryantii*	*Neotoma macrotus*	*Reithrodontomys megalotis*	*Thomomys bottae*	*Chaetodipus californicus*	*Rattus rattus*	unknown spp.	*Junco hyemalis*	*Zonotrichia leucophrys*	*Carpodacus purpureus*	*Stenopelmatus* spp.
		California meadow vole	Bryant's woodrat	big-eared woodrat	harvest mouse	Botta pocket gopher	California pocket mouse	black rat	unk rabbit	Dark-eyed Junco	White-crowned Sparrow	Purple Finch	Jerusalem cricket
Aliso 1	campus core	8	0	4	28	3	0	1	1	3	4	0	3
Aliso 2	campus core	3	2	4	4	2	1	0	0	0	0	0	1
Entrance	edge of core	4	0	0	40	0	1	0	0	0	2	1	8
Lewis	off campus	0	0	2	7	1	0	1	1	0	0	0	0
all		**15**	**2**	**10**	**79**	**6**	**2**	**2**	**2**	**3**	**6**	**1**	**12**

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