Fort Lewis
2008
Bat Survey

Final Report

prepared for

The Nature Conservancy

and

Fort Lewis
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Fish and Wildlife Division

by

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Summary

Worldwide, bats play critical ecological roles in insect control, plant pollination, and seed dissemination.[1] In North American ecosystems, bats control insects, and transfer nutrients from aquatic to upland habitats.[2],[3] Bat populations are in decline in North America. Habitat loss from development, industrial forest practices, and a general lack of protection can explain the bulk of the decline. Bats help indicate ecosystem health, and possibly act as early indicators of the effects of global climate change.

Much of the Fort Lewis undeveloped acreage more closely resembles the pre-urbanization, historic habitat than other lowland areas of western Washington. Mid-age and mature conifer and oak forests dominate the eastern two-thirds of the fort, and parts of the northwestern section.

The objectives of this study were to document the bat species present on the installation, to gather information on their distribution, and assess habitat associations. The discussion of this information includes recommendations to assist in the development of management plans. Results of this survey are compared to the 1992 and 1993 bat surveys, including a discussion of the changes in habitat and bat distribution. Forest practices, climate change, and the loss of old buildings are factors which drive changes in foraging and roosting habitat for bats.

Earlier studies have shown that 9 of the 45 species of bats found in North American[4] occur in the Puget Sound lowlands.[5] All nine were documented at Fort Lewis during this study. Maps showing their distribution and relative activity levels were generated and are included in this report, with a discussion of each species.

Fort Lewis provides high quality shelter and foraging opportunities for many bats, especially in areas that have large trees or moderately large bodies of open water. The installation's bat habitat is generally stable and suitable to support breeding populations over entire lifetimes. Echolocation (sonar) used to navigate is a short-distance imaging technique, and requires a great deal of learned routes and object recognition. Thus, changes in the landscape are believed to create greater disturbance to the foraging and reproductive success of bats. A pregnant Little Brown Bat, tagged with a numeric identification band during the 1992-3 study, was recaptured on June 12, 2008, at its original capture site near Chambers Lake. Most of the more popular foraging sites, and some of the historic roosts identified in 1992-3, are still occupied or used by bats.

Large decaying trees and snags were historically the preferred shelter for most of the bats in this area.[6] In addition to snag creation and retention, the addition of artificial roost structures in strategic locations could help offset the continual loss of vital roosting habitat. The retention of, or 'shoring up' of old, unused structures, especially the shelters and latrines found in the forested training areas, will help provide shelter to bats, especially the long-eared bats, which we found currently using them for roosting.

Habitat management practices which retain and create additional large snags, as well as retention of the forests near water and wet areas, will help ensure the long-term habitat viability for bats on the natural areas of the installation.

Introduction

The Fort Lewis Military Reservation is located in southwestern Pierce, and eastern Thurston counties in the southern Puget Sound region of western Washington State. Approximately 75% of the 86,176 acres within the fort's borders are undeveloped lowland conifer forest, oak savanna, and ephemeral wetland. These are managed as both multiple use (training, recreation, wildlife) and as restricted training areas. The balance is developed areas used for housing, support services, and industrial purposes. These undeveloped areas are generally suitable to support bat populations.

During the summer months of 2008, Cascadia Research and TNC personnel surveyed for bats in the undeveloped areas of Fort Lewis. To identify species of bats occurring at the installation, we used both traditional mist-net capture methods, and state-of-the-art acoustic sampling of bat echolocation calls[7]. Ninety-one (91) acoustic and twenty (20) net-capture survey events were completed between May 2 and September 30, 2008. Buildings, bridges, and other structures were sampled for indications of bat use.

An expansive wetland complex stretches from the town of Spanaway to Roy, surrounded by the largest remaining patches of oak-savanna in the Puget Sound region. Interrupted by only a few paved roads and a series of dirt roads, wildlife that has been extirpated from the surrounding area— the Western Gray Squirrel, for example—still maintain populations in the more protected and legacy habitats found on the installation.

Of the nine species of bat found in the Puget Sound lowlands,[8] most are present only during the spring and summer reproductive period, but several species have been shown to remain in the area and active all year.[9] During 2008, all nine species were documented as summer residents on Fort Lewis, including a few of the rare Townsend's Big-eared bats. Listed as a federal and a state '*species of concern*' (Table 1), Townsend's bats are difficult to document using either traditional mist-netting, or even the newer acoustic methods. The least-encountered species during these surveys, more could be learned from a targeted investigation to improve our understanding of their relationship to the habitats found at Fort Lewis. Three bats on the federal 'species of concern' lists, all forest dependent species, were documented. They were found in lower numbers, or more limited areas, than most of the 'unlisted' species.

Previous to this study, a bat survey was conducted at Fort Lewis over the summers of 1992[10] and 1993[11], prior to the development of portable digital bat call detection and analysis equipment. With the modern call detection and species identification methods, a greater number of samples can be collected at each site, producing a more robust data set than possible using capture methods. This recorded call analysis method also permits sampling at locations unsuitable for the traditional mist net method, and for species difficult to net. With the echolocation call systems, the recorded calls can be archived for later analysis including re-analysis when identification methods improve. For instance, 'neural network' system for reliably distinguishing the calls of Little Brown and Long-legged Myotis is nearly ready for testing. Using this system to reanalyze the '40 kHz myotis' calls from this study should improve our understanding of the abundance and distribution of the Long-legged myotis (*Myotis volans*) at Fort Lewis.

A relatively small body of bat research work exists for western Washington, even less for the lowland forests and prairies. This study expands the information available for habitat management, and the distribution of bats for the sensitive reproductive period. During the 91 survey nights (at 67 locations), over 15,000 echolocation call files were recorded at Fort Lewis.

Some species were encountered more frequently, and others were encountered less than expected, based on the results of the 1992 and 1993 bat surveys. Although Hoary Bats were the only species not represented among the 140 bats captured during 2008, more than half of the sites sampled acoustically in 2008 recorded the distinct Hoary Bat echolocation call. A more comprehensive accounting of bat distribution and abundance has been developed using a combination of the life history information (such as reproductive data) obtained with traditional capture, and the more detailed distribution data possible with the state-of-the-art ultrasonic recording and analysis methods performed for this study.

Table 1. Species documented occurring on Fort Lewis during 2008 bat survey. Presence of *Myotis keenii* (Keen's Myotis) is uncertain, pending genetic analysis results.

Scientific name	Common name	Federal conserv. status	State conserv. status	NatureServ ranking	Fort Lewis abundance[1]
Corynorhinus townsendii	Townsend's Big-eared Bat	Species of Concern	Species of Concern	S3	**1**
Lasionycteris noctivagans	Silver-haired Bat	-	-	S3S4	**5**
Lasiurus cinereus	Hoary Bat	-	-	S4	**3**
Eptesicus fuscus	Big Brown Bat	-	-	S5	**4**
Myotis californicus	California Myotis	-	-	S5	**4**
Myotis evotis	Long-eared Myotis	Species of Concern	-	S4	**3**
Myotis lucifugus	Little Brown Myotis	-	-	S5	**5**
Myotis volans	Long-legged Myotis	Species of Concern	-	S3S4	**2**
Myotis yumanensis	Yuma Myotis	Species of Concern		S5	**3**
(Myotis keenii)[2]	(Keen's Myotis)	Species of Concern	Species of Concern	S1	**unknown**

[1] Estimated relative abundance, based on 2008 survey data, 5=common, 1=few detections.
[2] *M. Keenii* : It is unknown if its range includes the study area; the closest known populations are on the Olympic Peninsula. We are awaiting the DNA test results for biopsy samples taken from 3 possible *M. Keenii*.

Study area

Site selection

The Fort Lewis military installation, located south of Tacoma, Washington, contains approximately 54,500 acres of forest lands, 11,000 acres of prairies, and over 15,000 acres of developed or residential land. The installation includes approximately 1,000 acres of lakes and 3,500 acres of wetlands.[12] An ideal bat survey would sample all habitat types periodically, from at least May through September, to detect roosting and foraging behavior changes through this reproductive period. Uncontrollable factors, especially inclement weather and changing access to training areas, led us to sample a large number of sites representative of 8 habitat types, and to analyze the data pooled by habitat type. The habitat classifications used to describe sample sites in this study are:

wet edge	Marsh, wetland without significant open water
dry edge	Forest edge (clearing, non-native vegetation)
wet corridor	Riparian forest (stream in the forest)
dry corridor	Dry forest corridor (road, pipeline)
wet savannah	Savanna with sparse trees, near a marsh, pond, or stream
dry savanna	Savanna (grass or shrub land with sparse oak or pine stands)
wet open	Large open water (lake, pond, or river)
dry open	Open field, non-native or no vegetation

In this study, we attempted to include a broad sampling of all non-developed, accessible land, within the constraints of troop training schedules and safety of survey personnel. The sites sampled are representative of the landscape types found on Fort Lewis, however, certain high-security areas and training areas, such as the artillery impact areas, were off-limits during this study. We believe that by sampling the perimeters of these areas, as well as sampling similar habitat types on the installation, we are able to make a reasonable prediction of species occurrence at these limited-access areas.

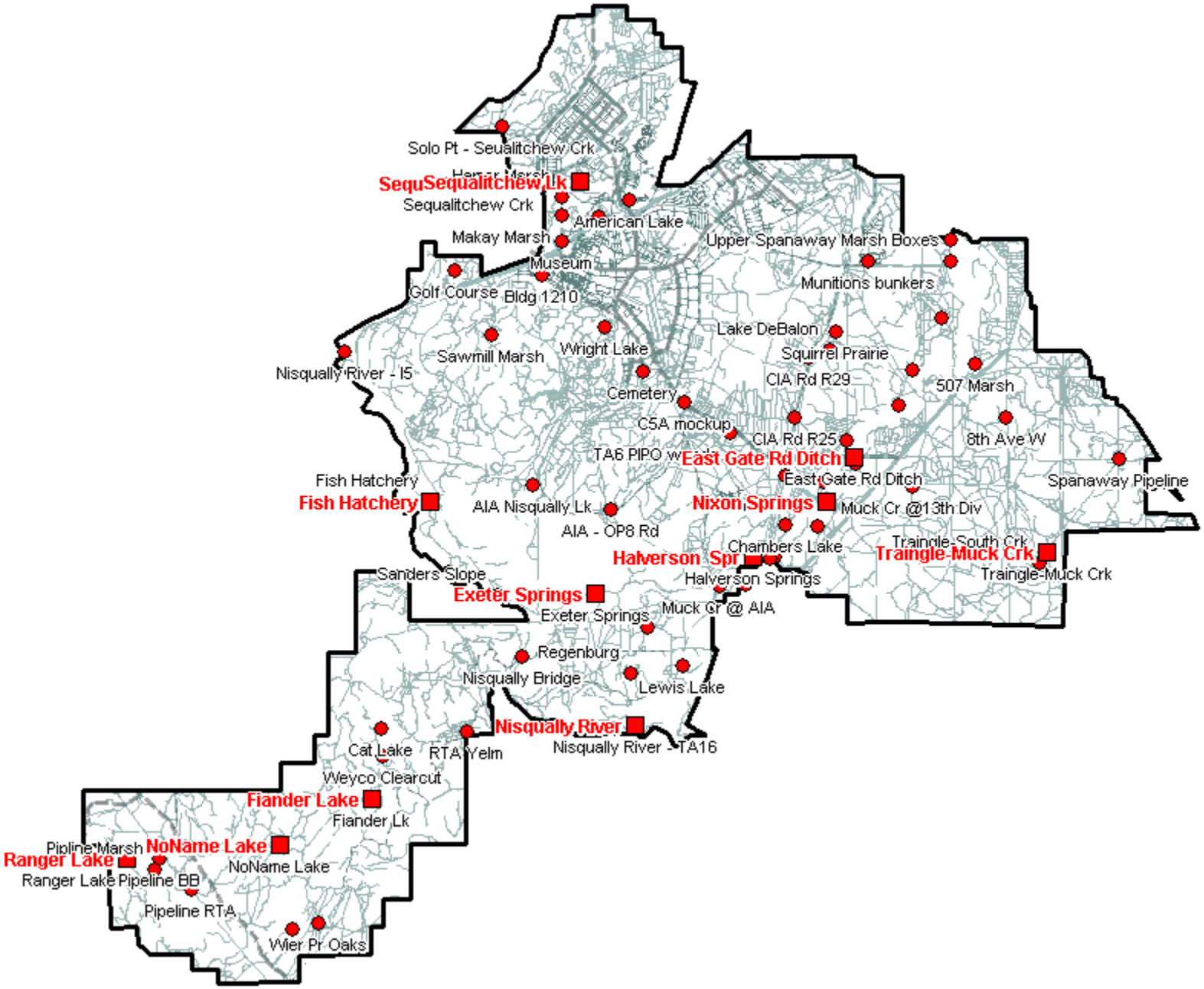


Figure 1. Net and Acoustic Sample Sites (see Table 5).
Solid squares indicate net sites.

Methods

Overview

A modified protocol based on the Oregon Bat Grid system[13] was used to sample non-random sites on Fort Lewis within habitats suitable for bats. Sites were chosen to represent specific habitat types and to spread the effort across the extent of the base. A total of 67 acoustic sites and 15 net capture sites were sampled.

This approach was designed to identify species diversity within the study area, and to infer differences in activity levels among species at the different habitat types. Sites selected for netting included the more productive sites identified during the 1992 and 1993 bat surveys, where enough data was collected during both surveys to permit some analysis of changes in species composition between the earlier and current surveys.

Period and schedule

The surveys were performed between May 2nd and September 26th, 2008. On each effort night, mist nets or acoustic recording equipment were in place by sunset, deployed until midnight, for a sampling period of approximately 3.5 hours. This time frame included the highest activity period, the hour between 21:30 and 22:30, when over 60% of the bats were captured (Figure2).Two to three sites were sampled with acoustic methods on each survey night. On capture nights, echolocation calls were recorded to document all bat species present in the vicinity of the nets, whether or not they were captured. Sampling was not performed on rainy or windy nights, when bat activity is considerably lower than normal, and when acoustic recording equipment is continually triggered by environment-generated noises. The weather was rainy during most of May, so only limited netting and acoustic surveying was performed after the first week of May.

Net Capture Methods

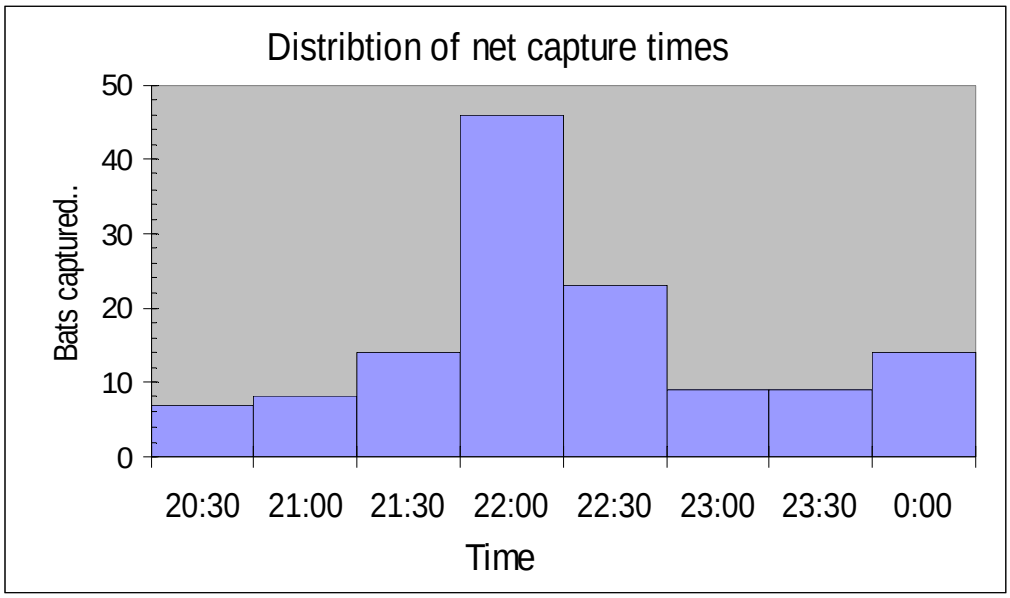
Bats captured provided life history data that could not be obtained from the acoustic data. Across the small scale of a survey site like Fort Lewis, the distribution data obtained from netting is less relevant, as the number of sampled individuals and number of sample sites is relatively small.

Capture and handling of all bats were performed in accordance with the guidelines published by the British Columbia Ministry of Environment, *Inventory Methods for Bats*.[14] Captured bats were examined and released at the capture site as soon as practical, in most cases less than an hour after capture. All bats captured were in good physical condition when released, with no apparent injuries incurred during capture and examination procedures.

Each captured bat was weighed on a digital scale (resolution 0.10 gram), and forearm measured (resolution 0.25 mm). Each bat was examined to determine sex, age class, and reproductive status following standard methods used in bat research.[15] Each was recorded as juvenile or adult, and the reproductive status of females was recorded as pregnant, lactating, or non-reproductive, and males as non-reproductive or testes development.

For most individuals, echolocation calls were recorded upon release (time-expansion, same as acoustic sampling), for use in species identification confirmation and to supplement the local *reference call* library. A skin biopsy for genetic analysis was taken from few individuals of each species, for submission to the Pacific Northwest "bat grid" baseline study, coordinated by the US Forest Service office, Eugene, Oregon.

Figure 2. Times of net captures illustrates netting occurred during highest activity times.



For each capture survey, 2 or 3 mist nets were placed in locations judged as likely to be in the path of passing bats. The longest nets suitable for each location were used, to maximize the capture area, most ranged from 6 to 18 meters long. The standard net height is 2.8 meters, generally suitable for streams, corridors in wooded areas, and foraging areas over open water. An elevated net was used for selected locations where we felt that more height would improve our capture success. This elevated arrangement could accommodate up to 3 standard nets vertically, placing the top of the highest net at 7.5 meters.

There was little or no correlation between amount of net and quantity of bats captured; location and weather appeared to be the greater determinants. For example, on July 10, at Muck Creek, 16 bats were captured in one 9 meter net, and only 3 additional bats were captured in the 2 other nets--all within a 100-meter stretch of Muck Creek. Investigations into the variability in capture success have concluded that weather, time of year (life-cycle stage), and roost availability have the largest effect on bat distribution on a given night.[16]

Nets were placed so that they could be tended by a minimum of 2 personnel, with frequent inspection for bats, typically every 15 minutes. Only those with a current rabies vaccination handled bats, though there was no evidence of illness or poor health among the captured bats during this survey. Bats were carefully removed from mist nets, transferred to cloth bags for holding, while waiting processing. After processing, captured bats were re-warmed if necessary, and released at the capture site. Echolocation calls were recorded upon release.

Significant species bias can occur when sampling bats by capturing them in nets,[17] or by recording their echolocation calls. Also, both in-the-hand methods for identifying species and acoustic call analysis are problematic for certain 'cryptic' species. The combination of the two methods is the best available survey method, especially with the addition of manual searches for roosting bats around buildings and bridges.

Capturing bats with mist nets favors those species which travel or feed, relatively low, and along corridors, such as streams and road cuts in forests. Little Brown, California, Yuma, and Long-legged (or ‘Hairy-winged’) Myotis bats, and in some areas Big Brown bats, fall into this category.

However, in western Washington, Hoary and Silver-haired bats rarely fly low enough to encounter these nets. This is evident in our 2008 capture results, and other studies in the region.[18] The sample window for mist netting is physically small compared to the large area and height covered by the bats, even with elevated nets and multiple nets at a site.

Example of an 'elevated net' setup (Photo courtesy of J. Szewczak)

Acoustic Sampling Methods

Because all species of North American bats echolocate, surveying bats by sampling echolocation calls can more accurately capture the species active at a sample site. Acoustic sampling was performed using *time expansion* ultrasonic detectors designed for unattended recording of bat calls *(*Pettersson Elektronik AB, Uppsala, Sweden; Model D240x). Calls were recorded from sunset to midnight, then transferred to a computer for analysis. The digital sound files recorded in either '.mp3' or '.wav' format, were classified to species using SonoBat software (SonoBat, Arcata, Calif.), which permits viewing sonograms of the call under test, and comparison to reference calls which were collected locally and regionally.

Using this system, most bat species in the Pacific Northwest can be distinguished however; several species are difficult and sometimes impossible to separate from closely related species. The most difficult are the calls from two "40 kHz" bats, Long-legged Myotis and Little Brown Myotis bats. Many Little Brown calls can be confidently determined using characteristics detailed in the call analysis guide by Szewczak and Weller,[19] but most of the remaining 40 kHz samples share characteristics common to both species. Only occasionally do these calls contain acoustic features that permit confident classification to Long-legged Myotis, yet we know from recording released bats that these recording may or may not be either species.

Because of this dilemma, a conservative analysis approach will under-represent the presence of Long-legged Myotis bats. A similar situation exists with Big Brown and Silver-haired bats, but both make species-specific calls somewhat regularly. If more than just a few calls for either of the species are collected at a site, there is usually one or more samples with distinguishing characteristics. A behavior that helps with this is that both species tend to forage in an area for at least several minutes, if not hours, often providing an abundance of call samples.

The 1992 and 1993 Fort Lewis bat surveys used more simplistic bat detectors, tunable units (heterodyne technology) which do not provide the level of information needed for species-level

analyses. Some species activity generalizations were made during those surveys that were based on acoustic evidence, which was likely beyond the capability of the systems used, and this 2008 survey will address this for those species, most notably, the level of Hoary Bat activity reported at 13th Division Prairie. In our study, we observed Silver-haired bats exhibiting the behavior attributed to Hoary bats in the earlier study.

Detector locations were chosen to sample various habitat types. Within those habitats the detectors were placed to maximize the likelihood of capturing the calls of bats in the area. In forested habitats, the detectors were located near clearings, forest edges, or corridors, where bat activity is typically the highest. For ponds and other open water, the detectors were placed facing the open water. In open areas such as savanna, the detectors were placed facing trees or vegetation, where bats are often seen foraging. Fortunately, the higher flying bats, Hoary, Silver-haired, and Big Brown bats, all produce loud, low-frequency echolocations calls, which travel quite far compared to the smaller bats' higher pitch calls. This provides for a good sampling, even if they are foraging in canopy.

Generally, the most difficult to detect are the species which are most associated with foraging in tree canopy: Long-eared Myotis, Long-legged Myotis, and Townsend's Big-eared bats. Detecting Townsend's and Long-eared bats is compounded by the low-amplitude nature of their calls, limiting the range which they carry. This unevenness of call detectability creates a sample bias which prohibits treating all calls as though there is an equal probability of being sampled. Thus far, no calibration curves or correction system has been established to deal with these problems. This will be covered more in the following discussions, and it greatly impacts our ability to study Townsend's Big-eared bats.

Counting calls

> "*Although detection rates for the same species can be compared among samples, these data cannot be easily used to infer differences in relative abundance among bat species.*" (Perkins, 1990)[20]

More recently, the question of occurrence and occupancy has been evaluated for acoustic bat studies, by a group studying the Hoary bat, in Hawaii.[21] One of their conclusions was that using repeated sampling over a season will help even out variability in bat activity and detection success.

The most conservative practice of simple tabulation of species detected during a sample period avoids the bias of autocorrelation, that is, prevents recording a single bat making multiple passes past the microphone as multiple occurrences.[22] However, it does have the consequence of providing no indication of actual activity levels at a site, since a single bat pass is treated the same as 20 passes. In addition to reporting the more conservative approach, I have devised a relatively simple activity 'score' based upon 3 simple rules, when applied to an acoustic data set for a survey event (an evening of recordings), which provides a basic index for the amount of site usage by a detected bat species.

No detection is still recorded as "0," and one detection, as "1." Multiple successive passes by the same species are also scored a "1" until 15 minutes of successive detections have occurred, when that species is then assigned a "2." If a break in detections occurs, and the same species is recorded later in the sampling, then a "2" is assigned. The highest score is a "3," which is assigned when a bat species is present throughout the sampling period. This method indicated the sites of highest importance for each particular species.

Table 2. Activity codes used to indicate activity levels at acoustic survey sites.

Code	Indication	Interpretation
0	No bats of this species detected in recorded calls	This species was not present during the sample period (exceptions: *C. townsendii* & *M. evotis*).
1	One bat of this species detected	This species passed through, but may not be foraging in the sample area on this night (see discussion)
2	Two or more detections from this species (separate occurrences)	Likely foraging at sample site, more than an incidental passing bat.
3	Detections from this species heard throughout the evening.	This habitat is likely important to this species.

Buildings and structures

Buildings and bridges were inspected for signs of bat activity, such as guano accumulations as an indicator of night roosting. Sites outside of the cantonment area which we believed might provide either day or night shelter for bats were investigated. When possible, bats found during these searches were captured in hand nets and identified and measured as in the net surveys.

Results and discussion

Two data sets were developed during the survey, the capture data and the acoustic detection data (Table 3). Although net capture data was intended primarily to collect life history data, such as sex ratios, reproductive and age class information, it can be compared to previous studies as well. One-hundred forty (140) bats were captured, 130 during the mist-net trapping surveys, and 10 additional bats had-captured while roosting. Eight species were captured in mist nets or by hand, although one species, Townsend's Big-eared bat, was only found during roost searches. An individual discussion for each species appears at the end of this section, with distribution maps.

The large variability of species captured can be attributed to variables such as time of year, type of habitat, net placement, and weather.

Most species of bats can be identified by examining recordings of their echolocation calls.[23] During the 2008 surveys, over 15,000 calls were recorded during the 91 acoustic surveys events.

Table 3. Summary of bat species captured at net sites (n=15, captures at 12 sites), the number of sites each species was detected, and species detections at acoustic sampling sites (sites=67).

Common Name	Number Captured	Net sites with captures	Net sites with acoustic detection	Acoustic sites with detection
Townsend's Big-eared bat[1]	4[1]	0	1	2
Long-legged Myotis	3	2	10	16
Yuma Myotis	13	3	7	26
Long-eared Myotis	7[2]	2	7	32
Hoary bat[3]	0	0	6	41
Big brown bat	31	5	12	45
California Myotis	11	6[4]	9	51
Little Brown Myotis	58	11	12	51
Silver-haired bat	2	2	10	52
Yuma or Little Brown Myotis[5]	11	2	-	-

Notes:
[1] 4 were captured by hand, no net captures for this species.
[2] 3 were net captures, 4 were hand captures while roosting
[3] None captured, but calls recorded at a majority of sites.
[4] 4 captures were at net sites, 2 were hand captures while roosting.
[5] Captured bats which were not distinguishable to species, could be either species.

Acoustic survey results

We documented four or more species (4 to 9) at two-thirds acoustic survey sites (45 of the 67 sites). The large number of sample locations and individual events provided a more reliable data set for relative species activity and distribution. With few exceptions, we consistently recorded calls for more species than we were able to capture at a site. With this greater temporal and geographic coverage, combined with the lesser species bias inherent in acoustic sampling (with the notable exception for Townsend's Big-eared bats), a more accurate depiction of activity level for bats is possible, as opposed to traditional netting methods.[24]

During 1993 and 1994, an acoustic survey of bats in managed forests of western Washington was performed by Erickson and West.[25] That study, along with the 1992 and 1993 bat survey on Fort Lewis[26,27] provide reference points to which we can compare our 2008 observations.

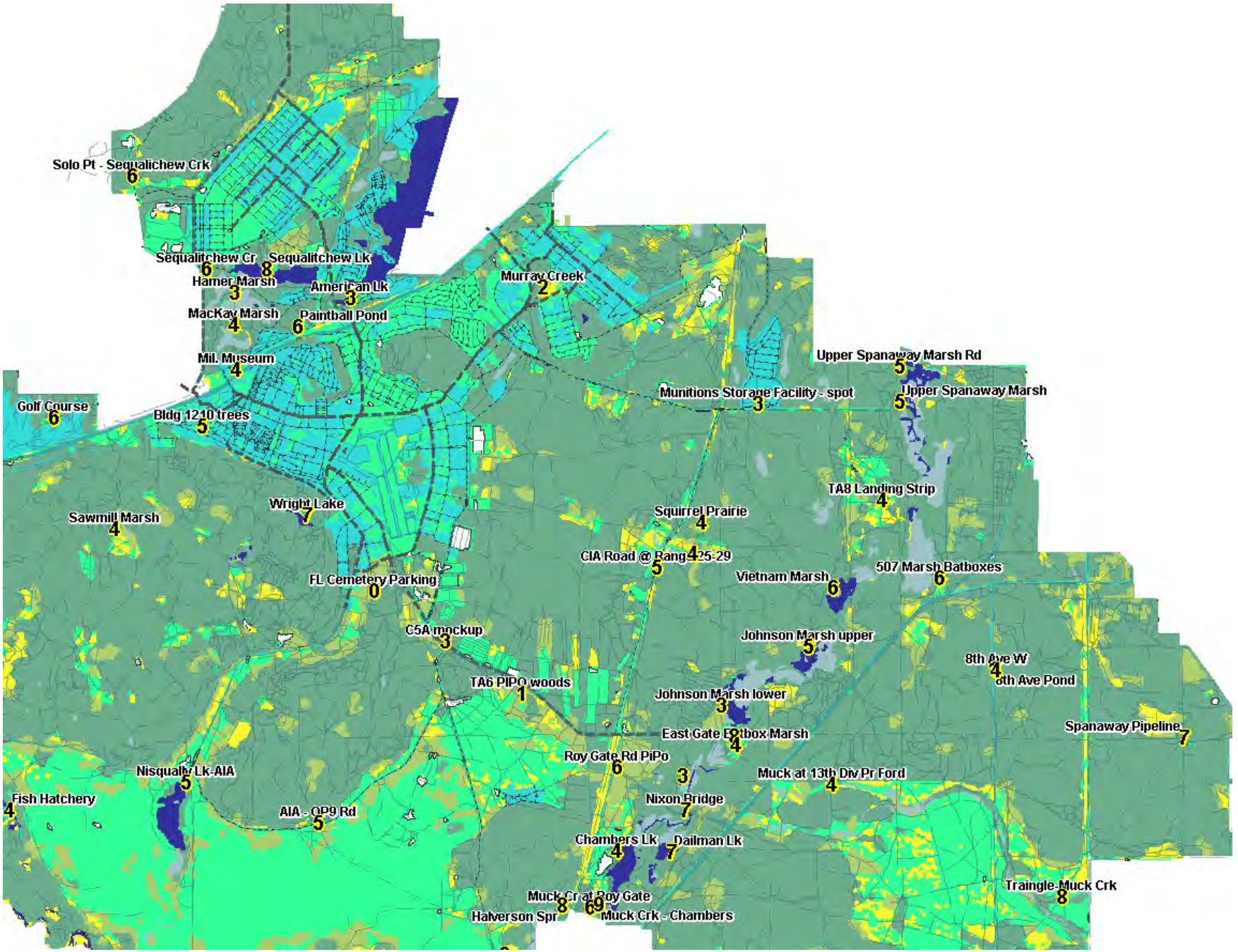


Figure 5. Map of acoustic survey sites (with no. of species detected) for North Fort, CIA, and East Fort.

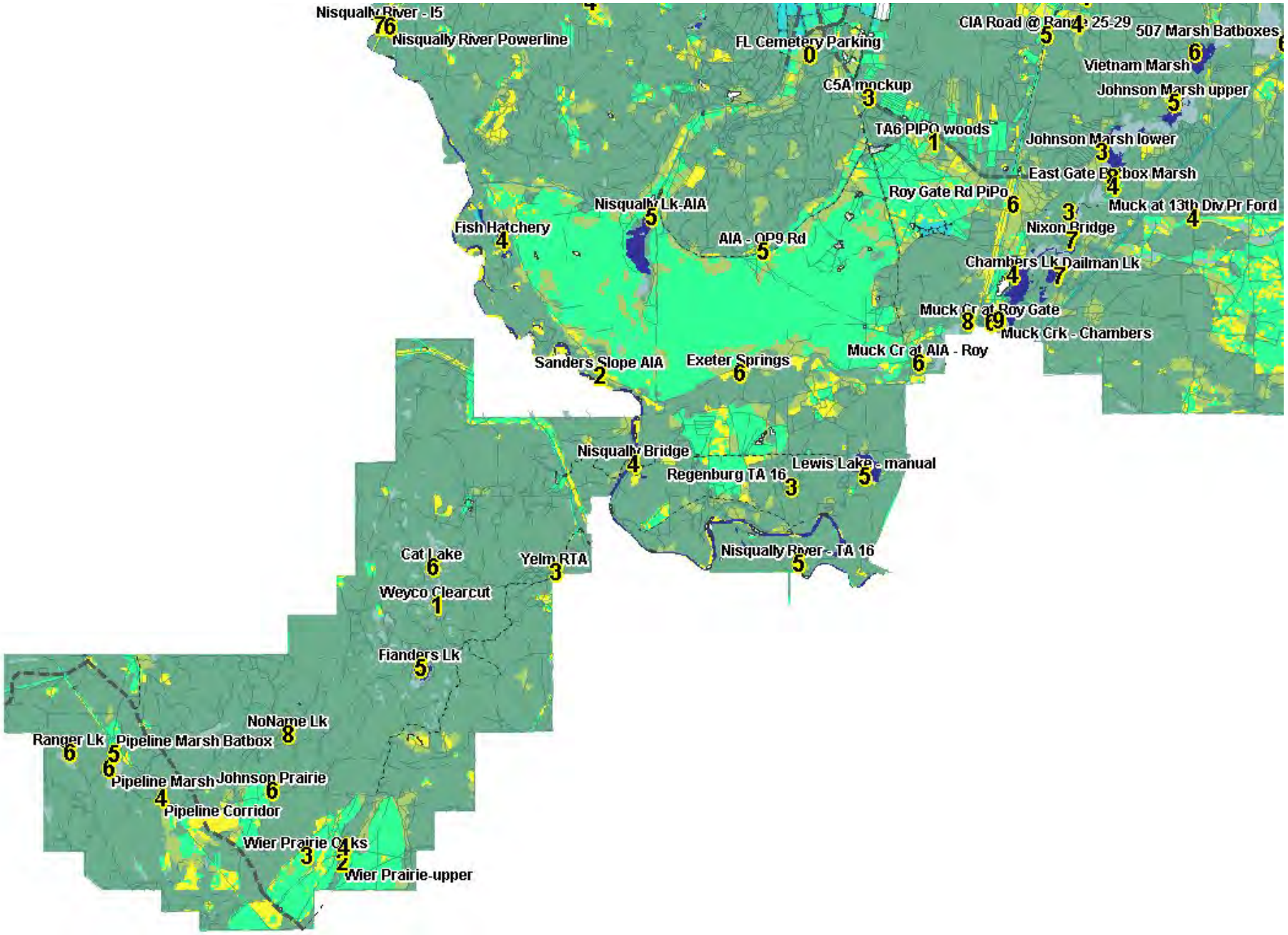
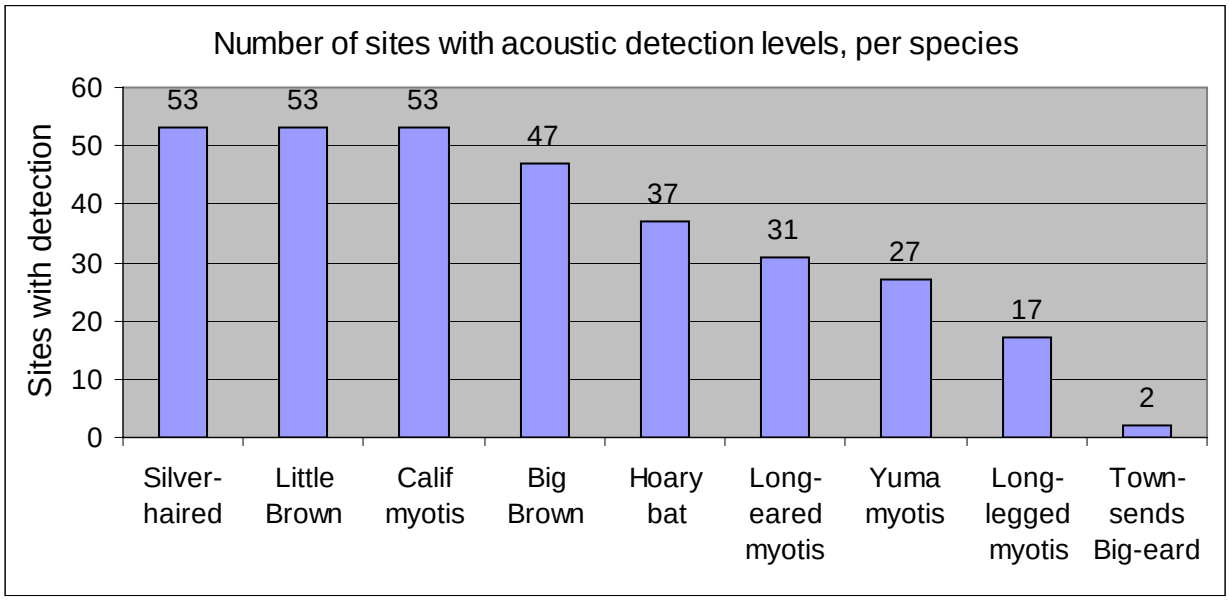


Figure 6. Map of acoustic survey sites (with no. of species detected) for the RTA, SIA, and AIA.

Erickson and West surveyed in various classes of second growth forests, and reported a mean of 3 to 4 bat call detections per survey event. No bat calls were detected on 46% of their survey nights. The technology for recording bat calls has improved since 1993; however the major improvement is in the ability to discern the species of the recorded bat calls rather than the ability to detect bat activity. In this 2008 study on Fort Lewis, we collected an average of 164 calls per survey event, and only one of the 91 acoustic surveys had no detections (the Fort Lewis Cemetery parking area). The newer Pettersson detector systems are generally considered superior for determining species identification, but the call detection rate is not an order of magnitude greater than the older Anabat equipment. This difference in average detection rates of over 40 times would suggest that the forests at Fort Lewis provide much better habitat for bats than the typical managed second-growth forest land. Factors such as detector location, and higher average elevations (more montane) of the Erickson and West study may account for some of the difference, but most of the higher level of acoustic detections at Fort Lewis is likely due to the availability of older tree stands, wetlands and forest edges, and open water.

Figure 4. Number of acoustic survey sites each bat species was encountered (total sites=67).



Estimating occupancy

Activity Index

The most conservative practice of simple tabulation of species detected during a sample period avoids the bias of autocorrelation, that is, prevents recording a single bat making multiple passes past the microphone as multiple occurrences.[28] However, it does have the consequence of providing no indication of actual activity levels at a site, since a single bat pass is treated the same as 20 passes. More recently, the question of occurrence vs. occupancy has been evaluated for acoustic-based bat studies, by a group studying the Hoary bat, in Hawaii.[29] After analyzing a large amount of acoustic data for the one species, they created a definition of occupancy for their goal of monitoring for population change. They suggest that more work is needed, but encourage more complex analysis than presence/absence for detecting change.

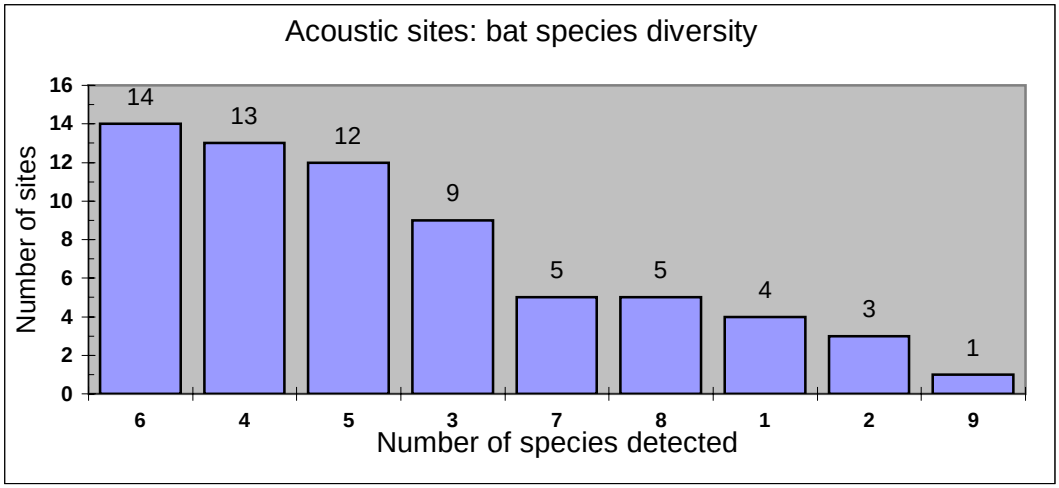
In addition to reporting the more conservative 'presence/absence' approach, I devised a relatively simple activity 'score' based upon 3 simple rules. When applied to an acoustic data set for a survey event (an evening of recordings), it provides a basic index for the amount of site usage by a detected bat species.

No detection is still recorded as "0," and one detection, as "1." Multiple successive passes by the same species are also scored a "1" until 15 minutes of successive detections have occurred, when that species is then assigned a "2." If a temporal break in detections occurs, and the same species is recorded later in the sampling, then a "2" is assigned. The highest score is a "3," which is assigned when a bat species is present throughout the sampling period.

Using this system patterns emerge which might be obscured by simply recording presence or absence for a species. The maps included with the species discussions use both systems; if there was any presence at a site, then a symbol appears, but the symbol size indicates the score assigned with this activity index. The principal application for this system in this report is the species maps.

The Yuma myotis map illustrates the value of this system. There were sites where a single pass from a Yuma bat was detected, probably a bat en route to a foraging area, or investigating a site for suitable open water, its preferred foraging habitat. These bats have been tracked commuting 10 or more km to feeding sites, so a passing bat does not necessarily indicate a nearby colony. However, after commuting to a feeding site, they may spend hours at an area as small as a few hectares. When a Yuma bat is detected more than once, it is often a feeding bat, and at a site it may utilize throughout an entire evening.[30] This system gives a better indication of preferred habitat or sites when analyzing these associations.

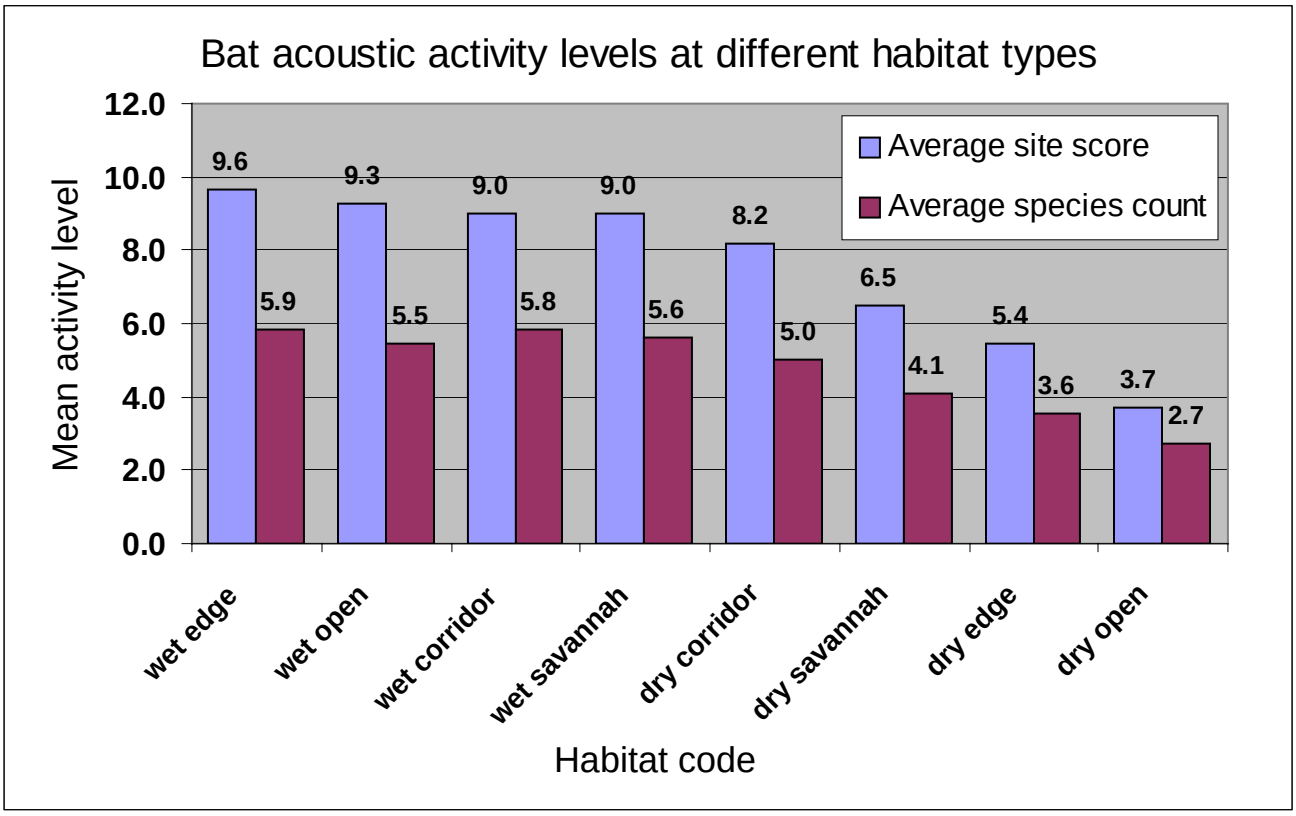
Figure 7. Frequency of sites for each total of species detected during acoustic surveys.



The ranking for the number of species observed at sites during acoustic surveys are graphed in Figure 3. Sixty-five percent (65%) of the sites fell in the mid-range of species diversity (4-6 detected species). Some sites benefited from sampling over multiple nights (range = 1 – 4 nights), however, the ranking of the most frequently encountered diversity indicator levels (3 – 6 species) was identical for individual surveys and for aggregated data for sites. A regression analysis to assess the relationship between the diversity-activity index and simple aggregate of species detected revealed that for a survey site, the count of species detected was a very good predictor of overall

bat activity (species and level of activity), with an R^2 of 0.98 (SE=0.16). In other words, sites where higher number of species is detected can be expected to be the sites more heavily used by bats.

Figure 8. Comparison of average of bat acoustic levels for the 8 habitat types.



Habitat code descriptions:

wet edge	14 sites	Tree edge near marsh or wetland, without significant open water
dry edge	7 sites	Forest edge (clearing, non-native vegetation)
wet corridor	6 sites	Riparian forest (stream in the forest)
dry corridor	6 sites	Dry forest corridor (road, pipeline)
wet savanna	6 sites	Savanna with sparse trees, near a marsh, pond, or stream
dry savanna	10 sites	Savanna (grass or shrub land with sparse oak or pine stands)
wet open	11 sites	Large open water (lake, pond, or river)
dry open	7 sites	Open field, non-native or no vegetation

Net survey results

The 20 trapping nights yielded 130 bats, captured at 12 individual sites. After the mist-net trapping was completed, an additional 10 bats were captured using hand nets, encountered during building searches in September. Figure 2 summarizes the net data, which is tabulated in Table 2.

The reproductive data and measurement data collected from the captured bats were consistent with other surveys. There was some indication of late gestation and parturition, possible by 2 – 4 weeks, based on the dates that some pregnant and lactating female bats were observed. Other researchers conducting surveys in Oregon and Washington states reported a similar trend this year[31], believed to be a result of cold and wet weather during much of May, the primary period of gestation for Pacific Northwest bats.

One bat species, the California myotis, was captured in much lower proportions during this 2008 study (n=10) than in 1992 (n=68) and1993 (n=24). The total number of bats of any species net-captured during these three years were similar (within 10%), so this may indicate a change in the local population for this species. Long-eared myotis were also captured in lower numbers this year, at about half the rate as in 1992 and 1993. Both of these species are closely associated with forests for roosting and feeding. The number of Yuma myotis captured seemed low for the amount of habitat available. Possible reasons for this are discussed in detail in the individual species discussion at the end of this section.

All bats found in Washington State are insectivores, with two distinct feeding modes, hawking and gleaning. Most bats capture prey during flight, in a hawking manner, but some bats, the longer-eared species in particular; also glean insects off of surfaces. Moths, beetles, spiders, and all types of flies, from gnats to crane flies, are consumed by bats. Although size of insect appears to be a factor for selecting prey, studies show that bats are largely generalists, consuming the most abundant prey available.[32] The differences in preferred feeding habitats among bat species is more related to flight and echolocation specialization adapted to the habitat features.

Foraging requires a considerable energy expenditure[33], compelling bats to focus feeding effort in areas of higher prey quality. The foraging habitats will vary for different species, to account for differences in maneuverability near vegetation, physical constraints limiting maximum prey size, and distance from suitable day roosting sites.

Comparisons to earlier surveys

Thirty-one (31) Big Brown bats were captured during 2008. Only three were captured in 1992, and in 1993, none were captured. Their appearance at some sites seemed variable, which may indicate they are 'following the hatch' rather than regularly using the same areas every night. If true, then netting at a random location on a random night may produce far fewer or far more than would be indicated by a true average for the site. Also, in 1993, all captures were done with a 'harp trap' rather than mist nets, and the data from that year suggest that Big brown bats may more successfully evade capture in harp traps than mist nets.

Taken together, it can be seen that Little Brown bats are the most frequently captured in nets, and the have the highest acoustic activity levels. This is consistent with the capture data from the earlier studies, and with other studies in the area. They are fairly abundant, and exhibit flexible foraging and roosting strategies. Little Brown bats have adapted to human made structures for colonial roosts, and have probably found adequate roosting resources on and off of the installation.

Two patterns emerged from the 2008 acoustic data which was not evident from either the 2008 captures or the earlier studies. Both Hoary bats and Silver-haired bats were frequently recorded. It is believed that the bats of these two species that are in Washington State in the summer are likely to be male bats, with females traveling further north to have their young.[34]

1. Hoary bats were often present, usually detected as just a few calls recorded per sample event, but on occasion, they were prevalent at a site (see species discussion).
2. The Silver-haired bats, were consistently present at many of the sites where they were detected, or would come through in waves. Both of the bats have calls that can travel much longer distances than the higher pitch of the myotis bats, so there would be an expected bias toward their detections.

Table 4. Net capture details. Captures after 9/9/08 were hand captured while roosting.

Date	Site name	Towns-end's	Silver haired	Big Brown	Long-legged	Little Brown	Yuma Myotis	Calif. Bat	Long-eared	Yuma/ L Brown	Total
5/6/2008	Exeter Springs					2					2
5/16/2008	Fianders Lake										0
6/12/2008	Muck Crk at Chambers			1		6	5			2	14
6/30/2008	Fish Hatchery					3	1			1	5
7/2/2008	Sequalitchew Lake										0
7/7/2008	Halverson Springs				1	2					3
7/10/2008	Muck Crk at Chambers Lk			1		13	2	1		2	19
7/14/2008	Dailman Marsh		1			4					5
7/17/2008	Ranger Lake Outlet			4		2		1			7
7/21/2008	Muck Crk at Triangle Prairie										0
7/24/2008	Muck Crk at Chambers Lk			3		8	2		1	3	17
7/28/2008	Sequalitchew Creek			5		2					7
8/4/2008	Muck Crk at Roy gate				1	10	1		1	1	14
8/6/2008	Nixon Springs			1				1			2
8/11/2008	East Gate Rd Ditch			15		1		2		1	19
8/13/2008	Nisqually River - TA16					3					3
8/22/2008	Muck Crk at Chambers			1		1	2		1		5
9/3/2008	Muck Crk at Chambers					1		4		1	6
9/4/2008	Halverson Springs				1						1
9/9/2008	No Name Lake		1								1
9/12/2008	Range 26 culvert	1									1
9/13/2008	Observation Post 7								1		1
9/14/2008	Range 26 culvert							1			1
9/20/2008	Observation Post 8							1			1
9/20/2008	Observation Post 8								1		2
9/20/2008	Observation Post 3 latrine	1									1
9/20/2008	Observation Post 2								1		1
9/23/2008	Observation Post 3								1		1
9/23/2008	Observation Post 3	1									1
9/24/2008	Observation Post 3	1									1
	Totals	4	2	31	3	58	13	10	7	11	140

Bridges

Night roosting bats were observed at three concrete bridges, two along the Mounts Road-Nisqually River, and under the Nisqually River Bridge (tank crossing) in Training Area 18. On September 8, this tank crossing bridge had approximately 50 Yuma bats roosting in the crevices between the concrete slabs, singly and in clusters of up to 10 bats.

In Washington State, concrete bridges with enclosed spaces will hold heat late into the night. When located near foraging area, bats will often use bridges of that design when 'taking breaks' at night. During a July 2008 inspection, the Mounts Road Bridge over the railroad tracks, 600 meters south of Interstate 5, had several species roosting, for a total of approximately 10 bats. There was guano evidence of scattered night roosting under the highway bridge over the Nisqually River, 1.7 km south of Interstate 5, and one Myotis bat was observed night roosting on one evening. The acoustic data collected 1 km downriver, shows that Yuma myotis bats utilize the open water along in this stretch of the river. Like the tank crossing bridge 7 miles upriver, they are probably the bats most associated with the night roosting at this bridge.

An off-site concrete bridge (near Olympia) with chambers which are regularly used by night roosting bats.

Use of habitat by bats

The greatest diversity of species documented in the acoustic surveys occurred during the last week of July and first week of August. This is the time that the young of the year begin flying and foraging, when mothers begin to be free from the constraints of nursing. This dispersal period will often have the greatest diversity of bats at sites, but typically at lower usage levels than during the maternity season. It appears that during May and June, when the reproductive female bats have their highest energy requirements, they congregate at the most productive foraging locations. Then, when energy requirements relax, they spread more evenly across the landscape. This seasonal pattern indicates that bat surveys should occur throughout the summer to include both maternity and dispersal periods.

Forest

With few exceptions, the sites with the greatest number of bat species recorded were sites with nearby trees and some type of water feature, either lake, marsh, or stream. Most often this is a site with both a wet component and a forest edge, or corridor such as a stream. This is consistent with other studies, and indicates the importance of riparian influenced feeding strategies, and forest habitat for roosting.

A single notable exception for the high-diversity sites, those sites with 6 or more species documented, was the pipeline corridor near the east edge of Fort Lewis, where the paved East Gate Road ends. On August 22, during a single 3.5 hour acoustic survey, 7 species were recorded. This site is characterized by a wide corridor in a mature mixed-species forest, in close proximity to a large open area dominated by scotch broom. Besides Townsends', it was not surprising that Yuma myotis was the other missing species, since the site is well over 2 km from any water feature, a feature with which Yuma bats are highly associated..

Muck Creek bridge, near the outlet of Chambers Lake. Water flowed until late in August, 2008.

Forest riparian corridors, like Muck Creek at the outlet of Chambers Lake (shown above), were the most bat-active habitat sampled, both in this survey and previous ones. The Chambers Lake outlet site was one of the most diverse sites. This site appears to have changed little since the bat surveys of early the 1990s, and we set up nets under this bridge, as was done in those earlier surveys. This is the location where the Little Brown bat shown on this report cover was banded in 1992 or 1993, and where we recaptured her in 2008, pregnant and in very good physical condition. This apparent long-term fidelity to an area and a foraging routine has been documented with many bats, and should be one of the concerns for conservation planning. Changes in the landscape may adversely affect the survivability of local populations of bats, and could be one of the major influences on the recent dramatic declines. Having a prescribed amount of suitable habitat may not ensure established populations are maintained.

Near the C5A mockup, these sheds showed evidence of occasional night roosting around the posts, probably from bats dodging out of rainstorms.

Structures

A number of buildings, sheds, and bridges were inspected for signs of bat activity. The presence of roosting bats, or accumulations of guano are indicators of use. Appendix D details the results of these structure inspections.

Guano was found at a variety of these structures, most in small accumulations. This indicates intermittent, and typically, night use. Bats usually feed for a period, rest for a while, then feed again, repeating this several times per night. These rest breaks, referred to as *night roosting*, often take place at locations other than the day roosts, and typically near the foraging area. Trees with crevices, bat boxes, and snags with cavities, provide the safety and weather protection needed for night roosting.

Out-buildings and similar rural structures are found around the town of Roy, Wash, not far from the Muck Creek capture site. Bats previously captured at the Muck Creek site have been documented day-roosting in sheds and other buildings in nearby Roy (1.5 km away)[35], and bats captured at other nearby locations were tracked there as well (this study). The nearby day-roosting habitat available around Roy very likely contributes to the high bat activity of the Muck Creek capture site near Chambers Lake.

Two types of structures worthy of special note are the abandoned latrine sheds scattered throughout the wooded training areas, and the concrete observation posts overlooking the artillery impact area (AIA). Both of these provided roosting for Townsend's Big-eared bats. The observation posts appear to be unused at this time, judging from the condition of the interiors and the inoperable metal doors. If these concrete structures are no longer used for training purposes, their value to bats could be enhanced by limiting access to by humans with bat friendly doors. This is a matured mitigation technology that has been used with great success at the openings of abandoned mines and at caves used by bats. The current limited use of these observation posts indicates that they are good candidates for habitat enhancement. Technical assistance with bat friendly gating is available through a program of Bat Conservation International (BCI). BCI and the

Department of Defense are parties to a memorandum of understanding for this type of assistance.[36]

Abandoned latrines in the forested training areas are used by bats for day and night roosting. This came to our attention during the radio tracking of a Townsend's Big-eared bat. Although we do not know of the quantity of these and similar structures, it appears that there are a number of them that would be salvageable. Since we found bats using these and a partially collapsed wooden shed behind Range 18, these would be additional candidates for some effort to extend their useful life for use by forest bats. Some cross-bracing of walls would probably delay their collapse for some years.

Abandoned latrine similar to that used by Townsend's bats.

The 1992 Wunder report contains a list of buildings surveyed for bats that year. We did not attempt to re-survey the buildings in the cantonment area during this survey; however, we discussed bats encountered in buildings with the Fort Lewis DEH / pest control staff. Pest control staff at Fort Lewis DEH report that they respond to calls about bats in buildings fairly regularly. They use education about bats, closing entrance ways, and non-lethal methods when necessary to eradicate bats from occupied buildings. Although they have an attitude which promotes conservation of bats, they indicated a desire to be better informed of the differences among the species, especially which species are priorities for more conservation attention. They report that there are buildings with recurrent problems, so working with pest control to identify buildings where installing bat boxes could help reduce future problems is a strategy to conserve bat populations. A workshop about our local bats could also help them to decide how to deal with bat encounters.

When presented the list of buildings where bats were detected in 1992, the pest control staff noted that many of those same buildings still house bats. Specific items are covered in the Recommendations section of this report.

Structures like the observation posts could be made 'bat friendly' with a special door to exclude humans and predators, but allow bats to pass.

A maternity colony of at least 100 bats resides in the attic of the Military Museum, as it did in 1992. Apparently, it is sufficiently segregated from the occupied sections of the building to minimize interactions between bats and personnel in the museum. The current practice of containment might be working, but a proactive effort to encourage these bats to use an alternative roost structure outside the building would be prudent. This process can sometimes take years of experimenting with bat house locations and designs. The proximity of this breeding colony to the local wetlands, Sequalitchew Creek, and Sequalitchew Lake probably contribute to the long-term success of this colony.

Artificial roosts

During the spring of 2008, The Nature Conservancy and Cascadia Research installed 30 bat boxes of three designs at Fort Lewis, to supplement roost structures near foraging areas. This was a pilot project to test 3 different designs and compare placement strategies. Preliminary results indicate that some of them had been used in the first season, and individual bats have been observed day-roosting at 3 of the 10 placement locations. Two of these day-roosting bats were Long-eared myotis, a forest-dwelling bat considered more easily threatened by loss of its natural forest habitat.

A recent *Bat Conservation International* study[37] of artificial bat roosts reported that it can take up to several years for new bat boxes to be accepted and used. The rapid use by these boxes installed in 2008 may indicate a local shortage of natural roosting structures. Distribution of bats is

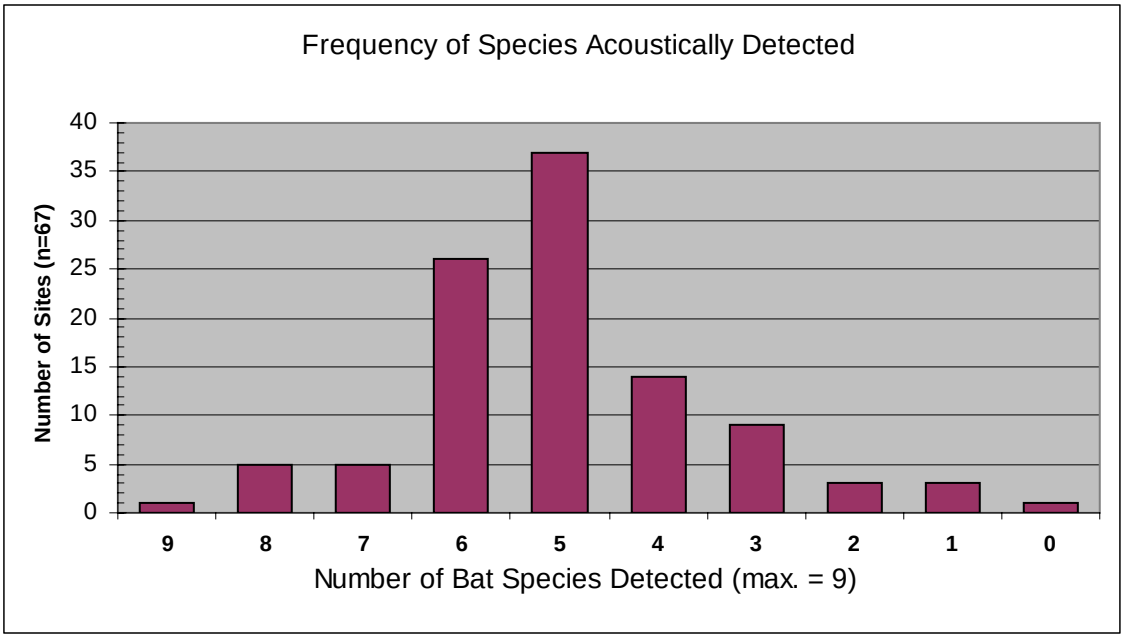
considered be a function of the availability of both foraging habitat and roosting opportunities.[38] Continued monitoring is needed, but this early success shows that local bat populations would likely benefit from an expansion of this program

Bat boxes in oak savanna near East Gate Road

Species discussion

Excellent and up-to-date species accounts have been developed by the Western Bat Working Group (WBWG), an inter-agency organization of bat researchers and species managers. They are kept updated and are available online.[39] Rather than repeat that information here, presented below are the information important to the discussion of the bats on Fort Lewis. These WBWG accounts and range maps include recent discoveries made with genetic examination, and should be referred to when species specific life history information is required. The working group is an active group of bat research and governmental regulatory professionals. The internet site is accessed via: http://www.wbwg.org/.

Figure 9. Distribution of the number bat species recorded in terms of species per site.



For a more relevant discussion of each bat species we documented, I have included some of the commonly accepted characteristics of each species along with added information, either from personal observations, or results of others' studies. Following each species description is a map showing the acoustic detection results, rated from no observations to high activity, as detailed earlier in Table 2, which is repeated below:

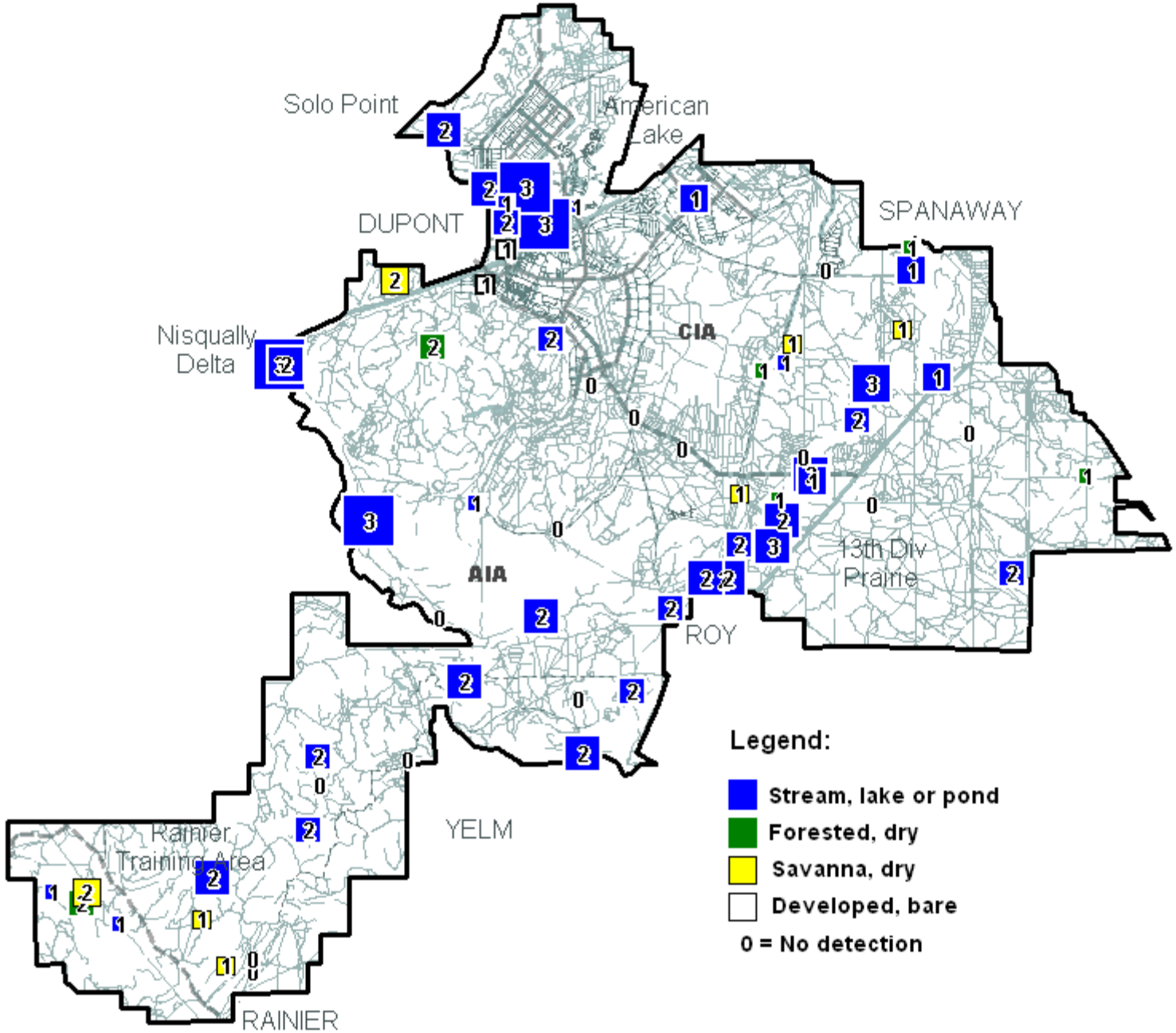
Code	Indication	Interpretation
0	No bats of this species detected in recorded calls	This species was not present during the sample period (exceptions: *C. townsendii* & *M. evotis*).
1	One bat of this species detected	This species passed through, but may not be foraging in the sample area on this night (see discussion)
2	Two or more detections from this species (separate occurrences)	Likely foraging at sample site, more than an incidental passing bat.
3	Detections from this species throughout the evening.	This habitat is likely important to this species.

Little Brown Bat – *Myotis lucifugus*

The Little brown bat is well described as the most common of bats in most parts of North America. This appears to be the case for western Washington,[40] as well as on the Fort Lewis installation. Little Brown bats comprised nearly half of the net captures, and calls were recorded at 53 of the 67 acoustic sites. The foraging habitats favored by this bat are open water when available, along streams, and among trees in open areas (road cuts and edges).[41] Except for year-round streams, these habitats are abundant at Fort Lewis. Little brown bat calls were recorded at every survey of Muck Creek, as well as all of the wetlands between Spanaway and Roy, and on down to the lower Nisqually River. Forty-nine (49) of the 56 adult Little Browns captured were female, consistent with other lowland surveys in the area[42] and with studies that find reproductive female bats generally in lower, more insect-rich locations.[43] The male bats are found at higher, cooler elevations. This partitioning is believed to allow the female bats, whose energy needs are considerably higher during the spring and summer, to take advantage of higher quality foraging locations, as well as benefit from warmer climate.

These bats tend to form large maternity roosts, usually in rural structures (barns and sheds), abandoned buildings, or attics of houses. They are often found roosting with Yuma myotis bats, but their feeding habits differ somewhat.

In earlier surveys, distinguishing these from Yuma bats was more problematic. Sharing many physical features, such as size, weight, and coloration, they can be close to impossible to tell apart when in the hand. Fortunately, their calls differ enough that with forearm measurement and call analysis with the newer full-spectrum methods, most can be reliably identified.[44]



Little Brown Bat Acoustic Results

California Myotis – *Myotis californicus*

California Myotis bats frequent woodlands and riparian areas of the western states. Although less abundant than Little Browns, locally they are regularly detected on bat detectors. They are also captured in mist nets in Pacific Northwest forests, but less frequently than Little Brown bats. They are the smallest bats in the region, and weigh between 4.5 and 5.5grams. Although not to the extent of the long-legged myotis, they have a call signature that can be difficult to distinguish from another species, the Yuma myotis.

These were recorded at 53 of the 67 acoustic sites. Although it was detected at the same frequency as the Little Brown and Silver-haired bats, they were not as abundant at those sites. It appears as though they do not forage as repetitively in the same area, but tend to cover a larger area than these other two species. This observation could also be an artifact of their higher frequency call, and therefore shorter distance covered, leading to fewer acoustic detections.

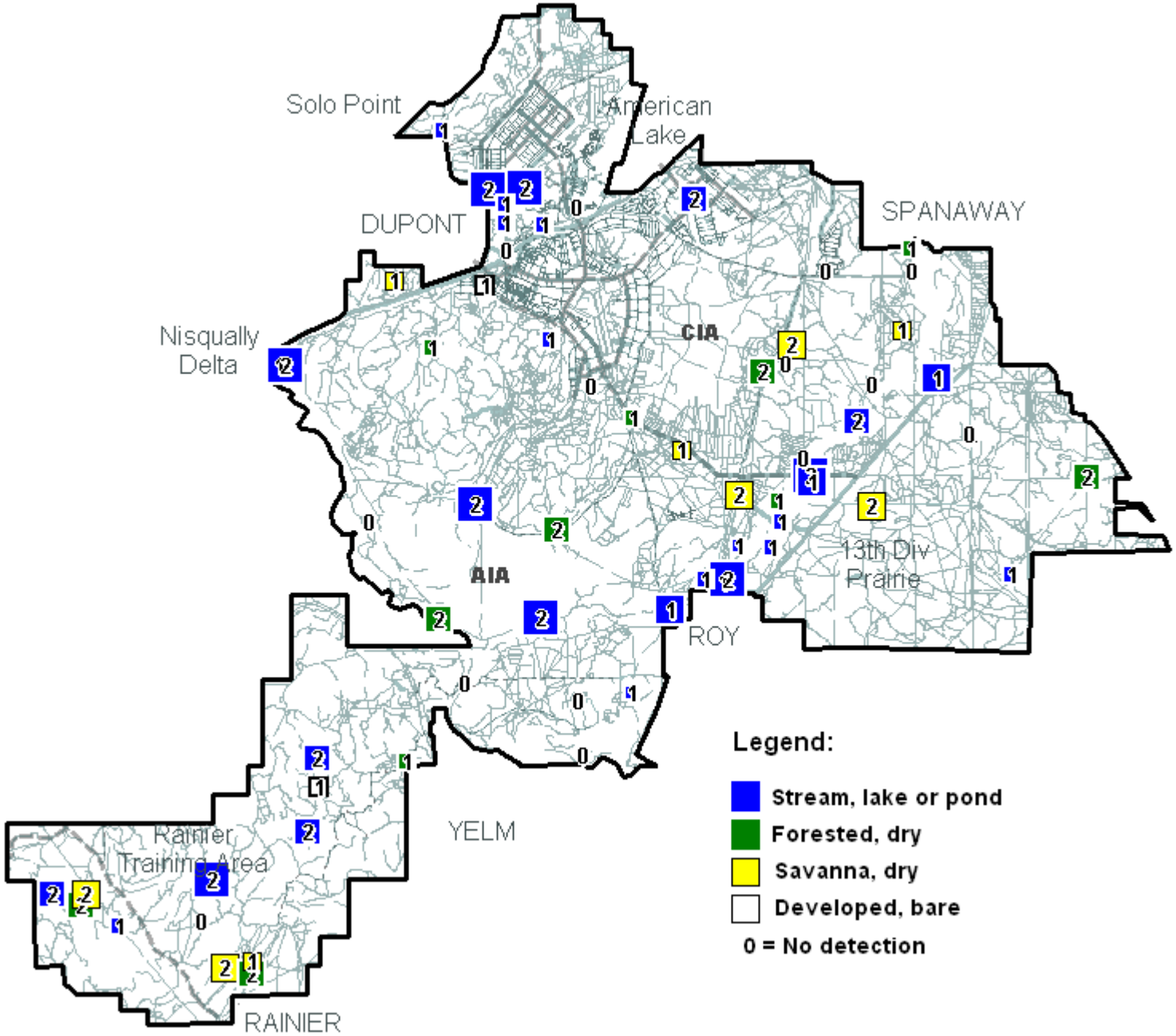
These bats have been found in numerous cracks and crevices in rural buildings, but not in large numbers or congregations. They tend to roost in structures near the wooded areas where they forage, and probably do not make commutes nearly as long as some of the other myotis bats.

These are one of the few winter residents in the Puget Sound region, typically found active year round, weather permitting. They specialize in edges of clearings, corridors through the woods as small as trails, and road cuts.

We captured California myotis at 4 of the 12 netting sites, all 4 sites were riparian, and either in, or close to, mixed-species forest. Two more California bats were hand-captured while night roosting adjacent to forests.

As discussed elsewhere in this report, the number of California myotis bats captured in this 2008 study is far fewer than the studies in the 1990s. The reason for the difference in levels is not obvious, but loss of roosting habitat is one possibility. In their natural setting, they are found under loose bark, in cavities in dead trees, especially snags that are in their last stages of decay. A multi-year study of California myotis roosting ecology in British Columbia forests was performed by Barclay and Brigham in the mid 1990s. They document a great deal of roost switching by these bats, and found that many of the roost snags used by the bats were near the end of their useful life, and not standing by the end of the study.

Loss of suitable roost snags may account for some of the change in numbers, and like most of our forest-dependent bats, will suffer from declines from the current commercial forest management practices used in the surrounding area off-installation.



California Myotis Acoustic Results

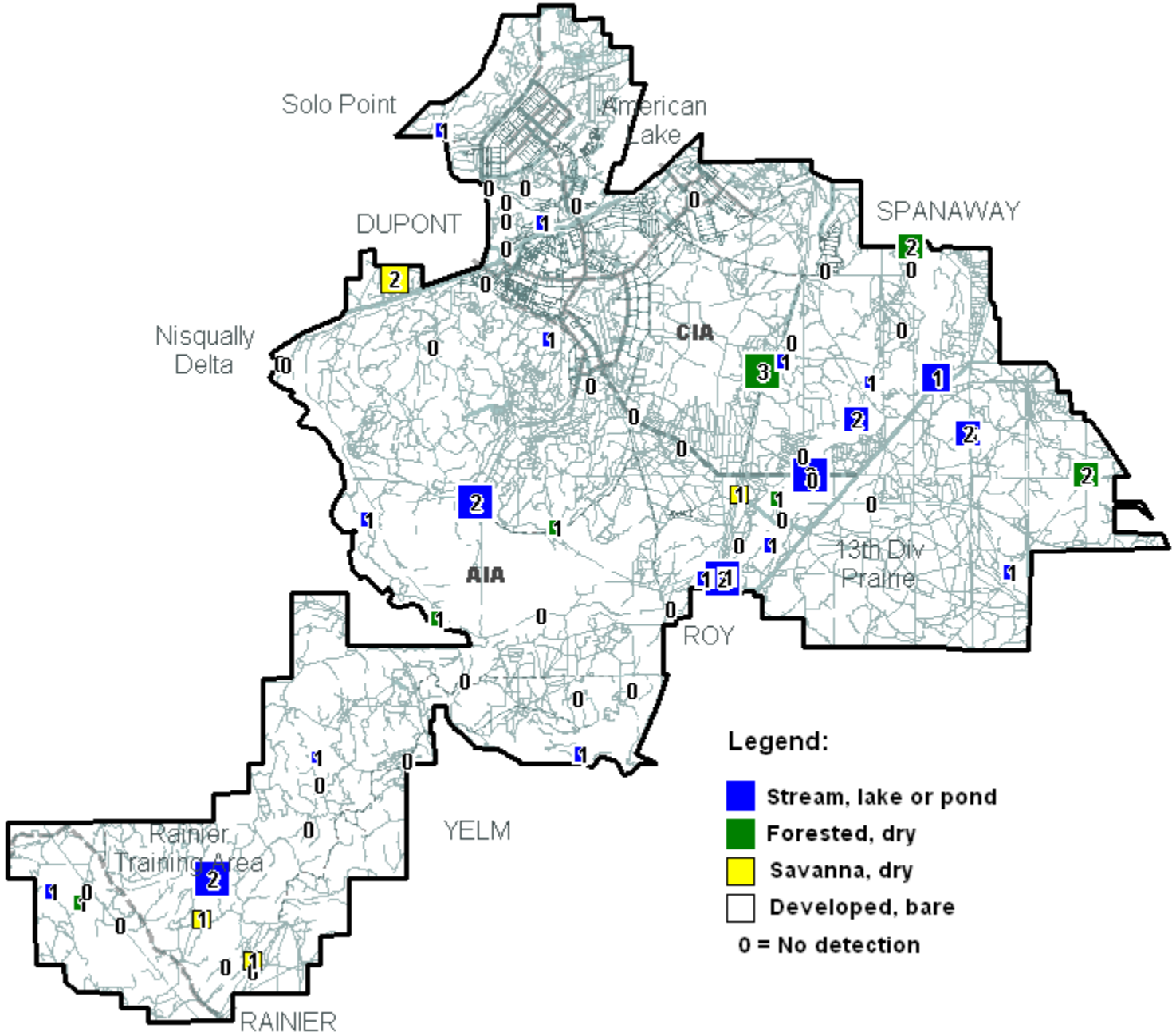
Western Long-eared Myotis – *Myotis evotis*

Western Long-eared Myotis calls were detected in the samples taken on most of the nights that the conifer forests were surveyed. Although quite soft, and only detectible over short distances, their call is distinct and relatively easy to identify, although it may be indistinguishable from that the Keen's myotis, a closely related long-eared myotis found in mature coastal Pacific Northwest forests. Southeast Alaska bat researchers recently collected acoustic samples for the purpose of developing reference calls for Keen's myotis.

The western long-eared is a highly maneuverable species which favors foraging within the forest canopy. This species was encountered at over half of the acoustic sampling sites, the majority along a mixed-species creek, or small bodies of open water. They were detected in all habitat types, but in very small numbers. This is consistent for an area that has an abundance of roost habitat, where foraging can occur 'close to home.' This species is known to be forest dependent, roosting in large stumps and snags, often in small groups or as single individuals. This bat was found day-roosting in 3 of the bat roost boxes installed by TNC and Cascadia Research during the spring of 2008. Improvement of roost habitat would likely benefit the long-term viability of this species.

Late in the season several Long-eared myotis bats were hand-captured while night roosting. Like the Townsend's Big-eared bats, these seem to be adept at detecting and evading capture in mist nets. These also have a lower volume echolocation call than most of our bats, making them more difficult to capture on recordings. They are likely more abundant than the detection tallies indicate, though their dependence on forests for feeding and day roosting is believed to constrain their distribution. A habitat management program that retained areas of older forest, and maintained a stock of snags, would benefit this species more than more generalist species.

Female Long-eared myotis hand-captured in concrete observation post while night roosting



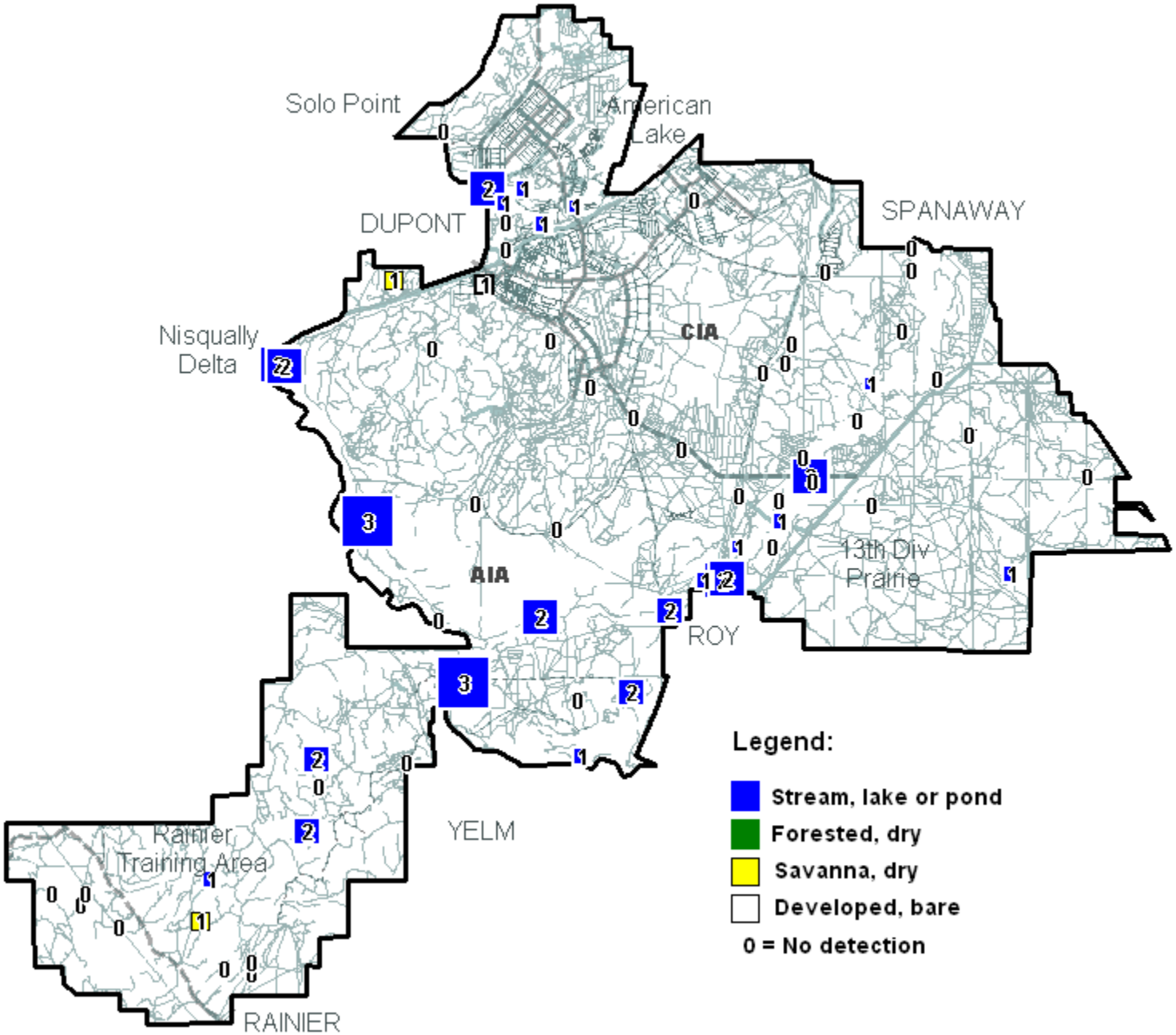
Western Long-eared Bat Acoustic Results

Yuma Myotis - *Myotis yumanensis*

The Yuma myotis, or Yuma bat is a common Northwest bat in areas with open water. They show a strong preference for water, for both foraging and roost selection. The largest known colony of bats in Washington state is a colony of Yuma and Little brown bats located under a pier at Woodard Bay, about 20 km west of Fort Lewis. Bats from the Woodard Bay colony commute 13 km to feed at a 650 acre lake, passing numerous wetlands, forest, and creeks.[45] At Fort Lewis, Yumas were detected at their preferred habitat of open water, but rarely at other habitat types. Thirteen Yuma bats were captured at only 3 sites, 80% of the adults captured were female. Almost all of the sites with Yuma Bat acoustic detections are classified at 'wet' sites (24 of the 27 sites), and half were at ponds or lakes. A small-insect specialist, they seem to specialize in small chironomid flies, such as midges and mosquitoes, feeding over large open bodies of water. The relatively loud, high-frequency call of the Yuma bat, when feeding over water is a reliable method for distinguishing this species.

In Washington State, reproductive female Yuma bats are usually found in large colonies of 1,000 to 3,000 individuals. Human-made structures typically provide the shelter for these maternity colonies, often in older structures with limited lifetimes. This communal clustering, in combination with their strong preference for feeding over large bodies of open water, may explain why their distribution is 'spotty.' Both conditions must be met, within their *commute range,* for this species to thrive. The Fort has a fair amount of foraging area suitable for Yuma Bats, especially Chambers Lake, Lewis Lake, the salmon hatchery, American Lake, and Lake Sequalitchew. All of the sampling along the Nisqually River indicated moderate to large numbers of Yuma bats, and the tanks bridge over the Nisqually was a favorite night roost for them.

The installation of Yuma-friendly bat house structures close to the preferred foraging habitat could help ensure long-term viability of Yuma bats. They will also benefit from night roosting shelter, used intermittently throughout the night while 'in the field.' We found night roosting Yuma Myotis bats around the porch at the fish hatchery, adjacent to one of the areas we captured and detected them. Fifty Yuma bats were observed roosting under the Nisqually River tank bridge, at midnight in late August. These were hanging singly and in groups of 2 to 12 bats, using gaps in the joints. Concrete bridges near open water are often popular night roosting locations, but a search of the Fort disclosed very few bridges of this type.



Yuma Bat Acoustic Results

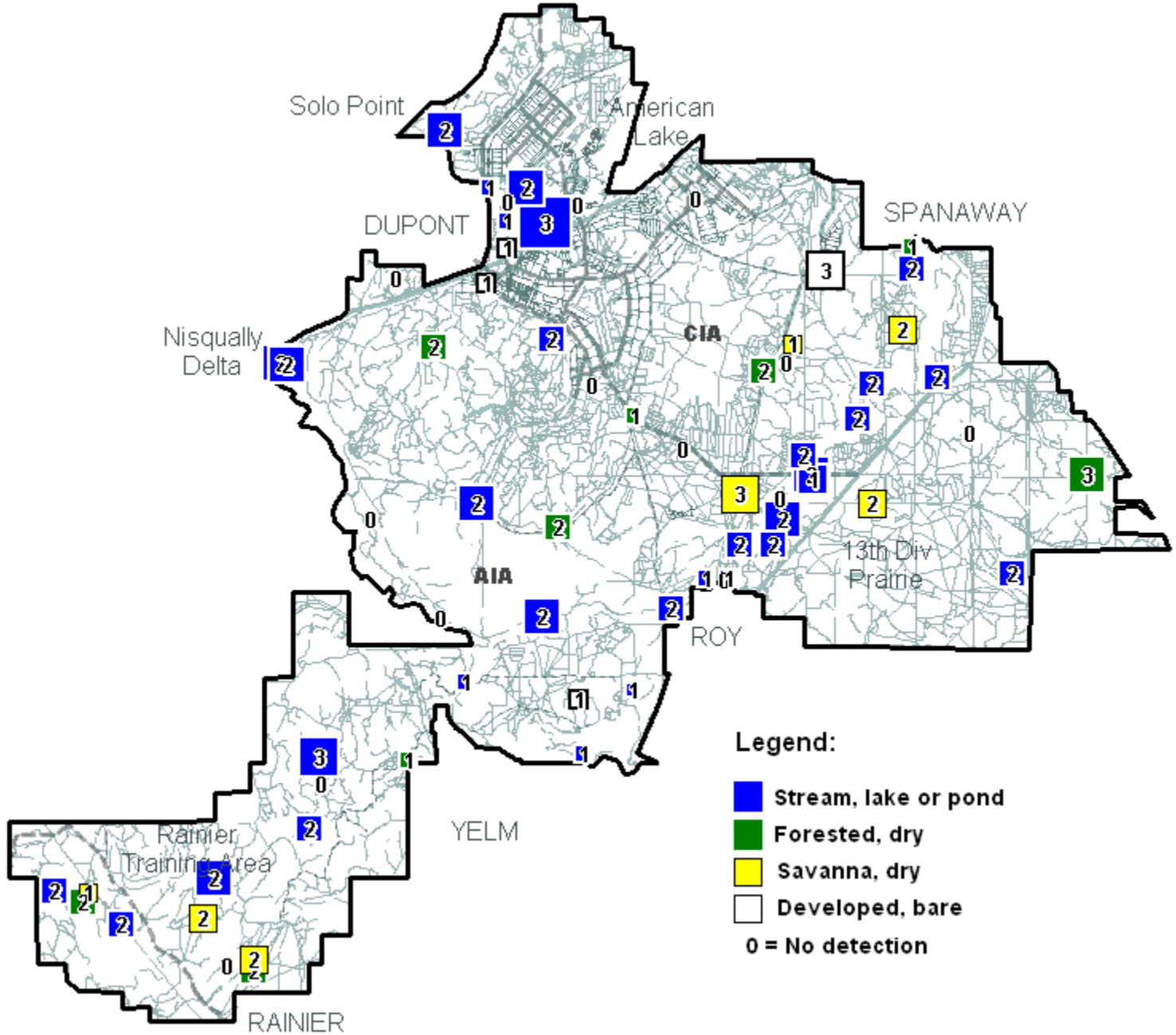
Silver-haired bat - *Lasionycteris noctivagans*

Silver-haired bat echolocation calls were recorded at 79% of the 67 acoustic surveys sites, yet only two were captured. The silver-haired bat can be difficult to capture in mist nets in the habitat types found at Fort Lewis, as they generally forage at elevations exceeding net heights, except when traveling in riparian corridors. Use of this vertical strata, documented in western Washington state forests by Hayes and Gruver,[46] likely contributed to the low number of Silver-haired captures and no Hoary captures. Both Silver-hair captures were made in elevated nets, at about twice the height of the standard net, and both were adult males. Like the Hoary bats, it is believed that most Silver-haired bats in Washington are male. Our small sample is consistent with that prediction.

A number of the call samples recorded during the survey could be from either a Big Brown or Silver-haired bat, and have been classified as “Epfu/Lano” calls. Where this species occurs, it usually lingers in an area for enough time to provide many call samples, so finding ones that were clearly Silver-haired calls was not difficult.

The call data ranks this bat equal to the most-often recorded call of the Little Brown bat. The loud, lower frequency calls of Silver-haired bats travel longer distances. If we had an accepted method to calibrate the results, it is quite likely that this equal occurrence with the Little Browns would actually represent somewhat fewer bats, which were detected from a greater range than the smaller bats.

Most (70%) of the calls recorded were from sites classified as ‘wet’. The dry sites where they were recorded the most were the more open edge and larger corridors. These bats will forage near, but not inside, forest canopy. This is probably do to maneuverability and echolocation call constraints. The 'clutter foragers' have short, fast, sweeping calls. The Silver-haired bat's call is characterized by a long, monotone call of fairly low frequency.



Silver-haired Bat Acoustic Results

Big brown bat – *Eptesicus fuscus*

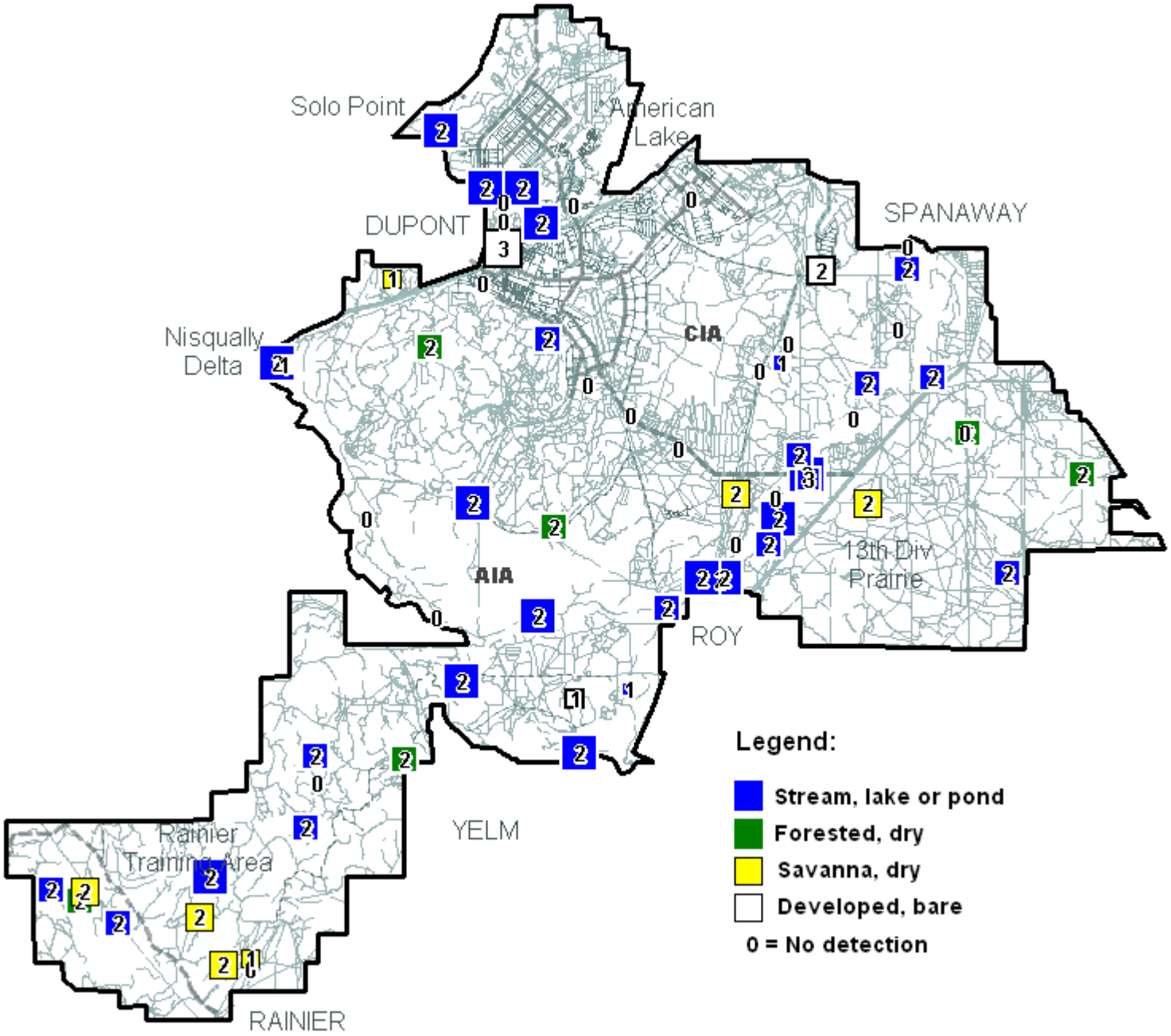
Big browns were found in nearly all of the non-urban habits on the base. A large and somewhat less maneuverable bat than most of the myotis species, they are known to favor open areas while they hunt for beetles and moths. Acoustic samples were recorded at 47 of the 67 sites, fourth in frequency of sites. Thirty-six percent (36%) of the acoustic survey sites were 'dry' sites, either nearby open prairie (native & non-native grasslands), or in the oak and conifer forests both on the developed areas of the installation. This is a fairly abundant species, typically foraging conspicuously, 5 to 20 meters high, over wetlands, along roads, rivers and streams, and over fields. Big Brown bat are usually found roosting in buildings and sheds, and seem to prefer warm spaces, such as attics.

We found that they would appear at sample sites with varying patterns, sometimes absent and some nights with great intensity, apparently in response to prey hatches. This was observed during both the acoustic and capture surveys. At all but 7 of the 47 acoustic sites where they were detected, they had greater than a "1" activity score, so if they appeared, it was usually in groups. With 31 captures, these were second to Little Brown bats (n=58) during mist-netting.

During these capture events, Big Brown bats took the record for a one-night capture of a single species. On August 11, we netted 15 Big Brown bats at the East Gate Road ditch that drains Johnson Marsh to the south. All but one of these were female. The lone male was a juvenile, apparently still traveling with the maternity colony. Most of the females were adults, which was not what we would expect so soon after the young would have started flying. The small percentage of juveniles at this site, and other sites, may indicate poor reproduction this year. Although we captured Big Browns most nights we netted at Muck Creek at Chambers Lake, all but one was an adult male. Since the adult males are not known to roost with maternity colonies, it would seem that there is not a maternity roost in the Roy area.

All of the remaining adult Big browns (other than these Muck Creek males) were female. After July 17th, sites with captures usually included young of the year (a single adult Big Brown was captured at one site).

A maternity colony has resided in the attic of the Military Museum for many years. Pest control staff report that it has not created a problem, but that eventually, maintenance on, or a remodel of the building may force its removal. It would be prudent to plan for that now, and attempt to lure the colony to an alternative roosting structure. We counted over 100 bats leaving the museum in late June. We presumed they were all or mostly adults, as we had not captured any young yet, and did not for several more weeks.



Big Brown Bat Acoustic Results

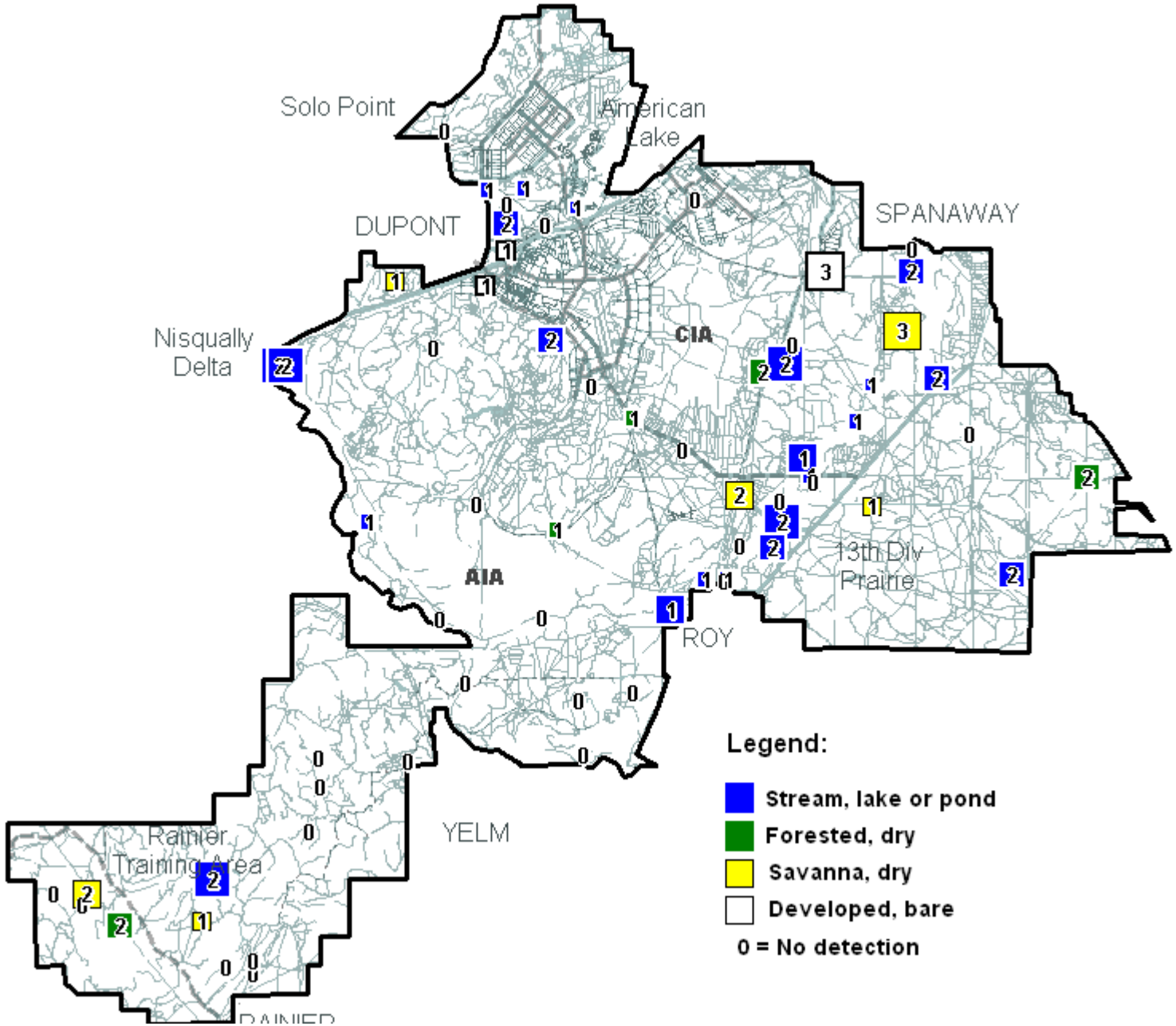
Hoary bat - *Lasiurus cinereus*

The Hoary bat is the largest bat residing in western Washington. It is a beautiful bat, but is seldom captured in this area. It forages at tree-top level, feeding on beetles and moths. At dusk, it can sometimes be observed sharing airspace with Silver-haired and Big Brown bats, flying long straight lines compared to the more maneuverable bats. This bat's echolocation calls are a distinctive long low-frequency segment, distinct to this species. The low frequency of their calls (19 kHz) permits them to propagate much farther than most of the Myotis bats, This makes their calls much more detectable than other bats, and therefore acoustic surveys have a bias toward Hoary bats.

Because Hoary bats forage higher than our nets reach, we rarely capture them, especially in western Washington. This is the only species not captured during this survey, yet they were acoustically detected at 37 of the 67 survey sites, placing them in the middle (5th place) in number of sites they were detected.

The 1992 Wunder survey report states that they saw and heard numerous Hoary bats near Muck Creek on the 13th Division Prairie. They report observing them flying shortly after sunset, coming out of the conifer canopy and foraging above the open area. Based on our experience in western Washington, and on our observations at that site during 2008, I believe it is more likely that some or most of these bats observed in 1992 were Silver-haired bats. The *heterodyne* style bat detectors used during the 1992 survey would not likely provide the level of information needed to make such a determination. Also, the likelihood of 20 to 30 Hoary bats foraging in one area[47] seems rather low, as these are generally territorial while feeding. They have been observed chasing off other bats, Hoarys and other species, during foraging. At No Name Lake we recorded a long bout of Hoary bats, by far the most recordings of any survey night, with a number of recordings containing the calls of 2 bats of this species. Included were a repeated ‘social call’ believed to be the warning signal associated with this territorial behavior.[48]

Hoary bats were detected at dry sites almost as often as wet sites, unlike most of the other species. Rarely did these bats have a high activity level at a site, and I believe that they tend to roam during foraging, rather than work an area like most of the other bats in this region. Also, if it is true that most of the Hoary bats in western Washington are male, then this roaming pattern would be more in line with the foraging behavior in male bats of other species. The Townsend's Big-eared bat radio tracked at Fort Leis this year traveled almost continuously along feeding routes, traveling to foraging areas over 6 km apart over a one-hour period, while the female Townsend's tracked in the same time period foraged in the same small area over and over. Of course this is a small sample size, but seems generally congruent with others' observations.



Hoary Bat Acoustic Results

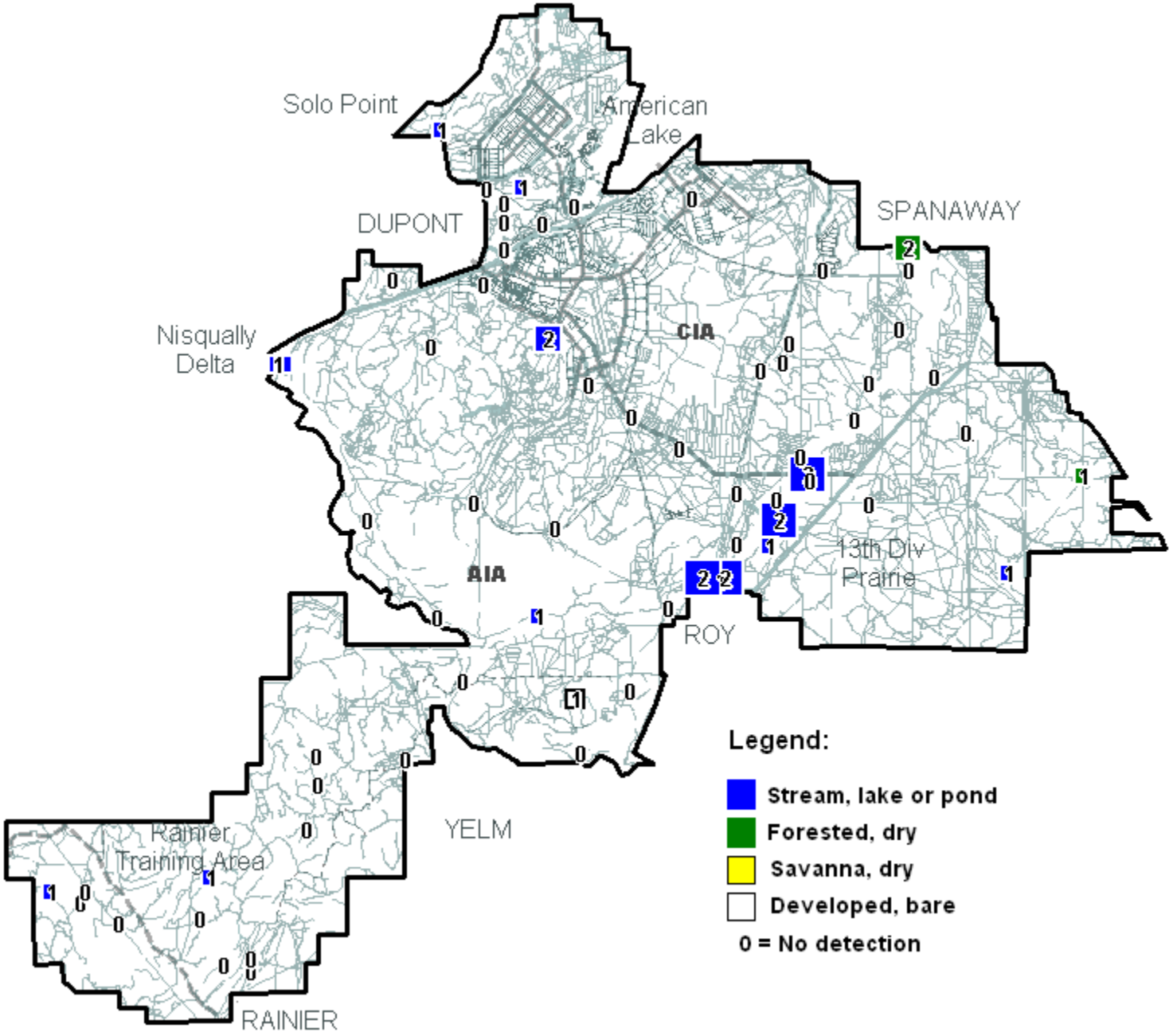
Long-legged Myotis - *Myotis volans*

The conifer forests occurring at Fort Lewis are an ideal foraging habitat type for Long-legged Myotis bats (*Myotis volans*). They are quite maneuverable, feeding along edges of the canopy and corridors within the forest, largely on moths. They typically form maternity roosts in large dead trees with exfoliating bark.[49] Most of their calls are indistinguishable from one of the most common Little Brown call type, so a captured bat is the most reliable method for species identification. This species was captured at the second lowest frequency (no Hoary bats captured) during the survey. At nearby McChord Air Force Base these were one of the most difficult bats to document as well.[50]

Based on the other forest bats documented during this survey, I believe it is likely to occur throughout the conifer forests on the installation, albeit in small numbers. It is quite likely that the absence of large snags is limiting the distribution of this bat in most Washington forests, including those at Fort Lewis. Studies in the central Cascade Mountains of Washington State indicate that the reproductive female Long-legged bats prefer roosting in large, tall snags, devoid of branches and near edges of forest canopy.[51]

There are likely more Long-legged myotis at the installation than were positively documented. The similarity of many of their calls to the calls of Little Brown bats, especially when foraging near clutter (foliage), their favored habitat, make it very difficult to correctly classify them. New software which uses automated analyses is under development, is believed to accurately separate the calls of these two species. We are very interested in re-running the call samples when this method becomes available.

This Long-legged myotis, one of the few captured, was netted at Halverson Springs



Long-legged Bat Acoustic Results

Townsend's big-eared Bat – *Corynorhinus townsendii*

Townsend's big-eared bats have a spotty, but statewide distribution. Because of the Townsends' sensitivity to roost disturbance an inventory of all known roosts is kept by Washington State Fish & Wildlife, and they are listed as a candidate species and are listed as a Federal 'species of concern'. We did not expect to detect them at Fort Lewis since the nearest known colony is 25 km away, on the Nisqually River near La Grande. This distance is probably greater than these bats would normally travel on a daily basis. The females are nearly always found in stable communal roosts, used year after year.

A colony was found adjacent to Fort Lewis during the 1992 surveys, in the attic of a church in the town of Roy. They had captured and radio-tagged a single female Townsend's bat, and tracked it for about a week. During 2008 surveys we did not encounter any of this species during the net-capture effort, but had confident acoustic detections at 2 different locations. Townsend's Big-eared bats have very quiet echolocation calls, earning them the nickname "the whispering bat." This low-amplitude characteristic greatly decreases the likelihood of detecting their echolocation calls, even when close to the detectors. The incidence of 'false negatives' is likely quite high. Surveys in 1993 and a study targeting Townsend's bats in 1996[52] failed to locate this species on the installation.

Things changed on September 12, 2008. Several days after completion of the scheduled net surveys, a single day-roosting male Townsend's Big-eared bat was found. It was captured near Range 26 in large (4-ft.) diameter concrete pipe. This individual was radio-tagged and tracked for 6 of 8 days. Every night while foraging, it traveled long distances, over 10 km. Although the Central Impact Area was its core foraging area, nighttime movements included the town of Roy, the area southeast of Vietnam Marsh, forests to the north of Lake DeBalon, downrange at Range 5, and the wooded hills west of Range 74 (Training Area 5), not far from the cemetery. For 6 of the 8 days the transmitter was operating, its behavior was closely monitored, with the hope to learn about preferences, and possibly lead us to female Townsend's bats in the area. This strategy succeeded in locating other Townsend's bats, but no maternity colony was located. During late September, 2 adult females and one juvenile male were documented in wooded area south of Range 76.

Only 2 acoustic detections were made for Townsend's Big-eared bats during the entire survey period of May 2 through September 9, 2008.

In 1990, the population estimate for the known colonies Townsend's Big-eared bats in Washington State was approximately 600 individuals.[53] There are fewer than a dozen known colonies, widely spaced across the state, though primarily in the western half. Central to the limited distribution of Townsend's Big-eared bats are two specialized requirements: they feed primarily on moths,[54] and they appear to have rather narrow requirements in maternity roost selection. Their echolocation is specialized for foraging close to vegetation, and for foiling the moths adapted to detect and evade bats using ultrasonic echolocation calls.

Studies show that Townsend's bats forage in a variety of habitat types, especially along woodland riparian corridors, mature forests, and open, vegetated fields. In the Pacific Northwest, moths are the primary prey for this species. During this study, foraging in the canopy of mixed conifer and close above the under story vegetation was observed. As well, the single male Townsend's bat tracked at Fort Lewis during 2008 foraged in savanna habitats, especially along the wooded edges of the rifle ranges ringing the Central Impact Area.

The radiotagged female Townsend's bat foraged primarily in older (est. 80-100 yr) conifer and mixed forests, and secondarily along the savanna interfacing the artillery impact area, immediately below observation posts 2 and 3, and in the forested area south of Kicker Hill. A light-tag temporarily attached to a different Townsend's Big-eared bat in this same area showed foraging movements both at lower-canopy level, approximately 8 to12 meters high, and along the tops of the understory, 1 to 2 meters above the ground.

Radio-tracking locations for the male Townsend's Big-eared bat, September, 2008 (6 days). All of the foraging observations for the female Townsend's bat were within the area enclosed by the polygon (7 nights).

In-depth behavioral study of Townsend's bats was not in the scope of the 2008 bat surveys, but extra effort (the radiotracking) was performed because of their 'sensitive' status and lack of information available to guide habitat management for this species. The observations for roost structures used and foraging preferences suggest that local populations need focused attention. It appears as though the known Townsend's maternity roost areas in western Washington all have late successional conifer forests nearby. This may be a habitat requirement. The post-reproductive Townsend's located in late September was in the area shown inside the blue polygon on the map that follows, an area with many large, decadent Douglas-fir.

One of the of structures that the radio-tracked male Townsend Big-eared bat used as both a day and a night roost.

The male Townsend's Big-eared Bat, as it was discovered on September 12.

Keen's Myotis - *Myotis keenii*

Keen's Myotis bats may occur in some parts of the Puget Sound region but are very difficult to document for two reasons:

- Using standard field methods they are considered indistinguishable from their close cousins, the Western Long-eared myotis,
- The echolocation calls are for this species are currently indistinguishable from those of the Western Long-eared Myotis (automated methods may overcome this).

These bats are on Washington's 'species of concern' list, in recognition of their limited and uncertain distribution, and their apparent dependence on mature conifer forests. With little of this habitat remaining, we may never know their historic numbers or range. Regardless, the range of the Keen's myotis bat is likely the smallest of all North American bats, limited to the coastal forests of Washington State, British Columbia, and Southeast Alaska.

There are no records of Keen’s in southern Puget Sound. Their range has been thought to be confined to the coastal old-growth conifer forests, coastal British Columbia, and parts of southeast Alaska. The closest Keen's records in the WDF&W database in the southeastern Olympics and on the south end of Whidbey Island. Pierce and Thurston Counties are outside the current GAP mapping for this species. Since so little is known about the distribution of these cryptic bats, we consider it a possibility that they may be present in the mature lowland conifer forests of Fort Lewis. Recent discoveries made using genetic analysis has shown that the identification confusion between two other sympatric bats—Yuma and Little Brown Myotis—have probably led to incorrect conclusions regarding their distribution and life history strategies. Around 2001, one long-eared myotis specimen collected in Thurston County was designated a possible Keen's Myotis[55].

These bats are typically captured while roosting under bridges, or netted during flight along forested riparian corridors. Little is know about the structure of their colonies, or roost structure preferences, but their strong association with older conifer forests suggests that they may use tree cavities and crevices. Like their Western Long-eared cousins, they have big ears and quiet calls, and appear to be rather successful at evading capture in mist nets. Because of their morphological similarity, to ensure correct identification, skin-tissue biopsies are taken for long-eared myotis captured in coastal areas of the Pacific Northwest. Keens' can be reliably distinguished from the western long-eared myotis using genetic analysis, thus we took non-lethal skin biopsy samples from 3 of the 7 long-eared *Myotis* bats captured at Fort Lewis during this study. The tissue samples have been submitted to the Portland University genetics lab for the DNA analysis. The results were not available in time to include in this report, but are expected by early 2009. If any samples show the presence of Keen's Myotis bats at Fort Lewis, a targeted investigation of long-eared bats would be warranted, considering their sensitive status. Oregon, Washington and British Columbia have identified Keen's Myotis as priority species for conservation, especially now that we can identify them with certainty utilizing DNA analysis.

Recommendations

Conservation needs

The frequency which forest-dwelling species were observed at Fort Lewis suggests that it is not too late for meaningful conservation of bats. Where lowland woodlands remain in western Washington State, the forests are generally lower-quality habitat as a result of even-age, single-species stand management practices. Retention of the unique maturing mixed species stands on the base will help keep the quality of habitat high. The surrounding region is not likely to ever achieve the habitat quality still found on parts of Fort Lewis. This study shows that the bats found at Fort Lewis favor wooded habits with fresh water features, especially streams, ponds, and lakes.

Although foraging habitat may be secure from significant changes in the short-term, the continuous loss of roosting locations, both on and off of Fort Lewis, will likely have a detrimental impact on these populations. Enhancement of roosting habitat could help stabilize populations that may find enough foraging opportunities, but are at risk from loss of shelter due to the loss of old buildings, snag removal, and human threats.

Below are specific recommendations, intended to have a direct benefit to bats. Most of these will benefit other wildlife species as well. The most important feature to protect is the mature and diverse woodlands near water or wet areas of all types.

Specific recommendations

1. Snag retention
    a. Retain snags over 30 cm DBH where ever they occur. Priority snags include those with cavities, including woodpecker holes, or with exfoliating bark. Tall snags at clearings are found most often used by reproductive colonies of 'forest bats.'

2. Large snag creation (50 -100 cm DBH)
    a. Conduct a survey, with a bat ecologist, to locate suitable candidates for future roost snags in the following priority areas:
        1. Between Range 79 and Kicker Hill
        2. Chambers Lake—Nixon Springs—Johnson Marsh area:
            1. Create conifer snags, especially large ones, and retain already damaged oaks
            2. Install artificial bat roost designed for Yuma myotis
        3. Rainier Training Area – anywhere possible
    b. Snag retention
        1. Ensure adherence to snag retention policies.[56]
        2. Review wildlife tree methods for harvests (such as clustering).

3. Create more artificial roost structures
    a. More bat boxes based on successful designs
    b. Larger bathhouses for maternity colonies of Yuma myotis and Little Brown bats
    c. Roost structure for cavern roosting bats (see 'Townsend's' sec. 7.a.1, below)

4. Water management
    a. Maintain diverse and mature forest structure near water features, including marshes, ponds, lakes, and streams.

b. Continue current weed management in upper Spanaway, Vietnam, and Johnson Marshes
c. Whenever possible, maintain water in Muck Creek below Chambers Lake (summer).
d. Whenever possible, maintain water level in Chambers Lake to maximize open water (summer).

5. Invasive species management
    a. Muck Creek in the 13th Division Prairie: Scotch broom and reed canary grass along stream channel.
    b. Maintain clearings and corridors in forests when new vegetation is not mandated in forest practices plan.

6. Research
    a. Townsend's Big-eared bats
        1. Perform follow-up monitoring for Townsend's bats
            - acoustic surveys in Sept. 2008 activity areas
            - roost-site monitoring at 2008 sites.
        2. Investigate and confirm presence of maternity colony (radio-telemetry)
            - determine extent of off-installation roosting and foraging activity.
            - determine the extent of on-installation activity.
            - determine the seasonality of occupancy of this species
    b. Targeted capture study for Long-eared and Keen's Myotis bats
        1. Determine if Keen's myotis is present:
            - genetic sample results from 2008 (only 3 biopsies)
            - continue genetic sampling in 2009
        2. Western Long-eared myotis:
            - determine if reproduction is occurring locally
            - investigate priority habitat if reproductive colonies on Ft. Lewis

7. Management for priority species
    a. Townsend's Big-eared bats :
        1. Create roosting habitat to supplement current structures
            - Artificial cave made from large concrete pipe.
            - Install 'bat friendly' security gates on doors on unused observation posts to enhance these cave-like structures.
        2. Retain natural forest features in areas in use by maternity population
            - Modify forest management (such as, curtail clearcutting) in areas used by reproductive Townsend's Big-eared bats.
            - Retain and rehabilitate abandoned wooden structures in wooded areas (old latrines, shelters).
    b. Long-eared myotis bats:
        1. Snag retention and forest practices, same as for Townsend's bats
        2. Similar forest practices would benefit Long-legged myotis bats as well.

8. Conduct training for pest control staff
    a. Increase their ability to identify priority bat species.
    b. Help develop an alternative roost strategy and program.

Table 5. Bat species detected at each acoustic survey site, with activity levels indicated. A zero indicates not detected, **bold site names** indicate more than one acoustic survey.

Site#	Site Name	Habitat class	Northing	Easting	Hoary bat	Little Brown	Yuma Bat	Calif. Bat	Long-eared	Long-legged	Big Brown	Silver-haired	Town-send's	Activity score	Species count
35	**Muck Crk at Chambers Lake**	wet_corr	5206755	535475	1	2	2	2	1	2	2	1	1	14	**9**
32	East Gate Ditch	wet_edge	5209678	537809	1	2	2	2	2	2	2	2	0	15	**8**
34	**No Name Lake**	wet_open	5198277	520897	2	2	1	2	2	1	2	2	0	14	**8**
37	**Sequalitchew Lake**	wet_open	5217792	529739	1	3	1	2	0	1	2	2	1	13	**8**
29	**Triangle-Muck Crk**	wet_sav	5206891	543476	2	2	1	1	1	1	2	2	0	12	**8**
38	**Halverson Spring**	wet_edge	5206745	534841	1	2	1	1	1	2	2	1	0	11	**8**
40	Nisqually River near I5	wet_edge	5212806	522774	2	3	2	1	0	1	2	2	0	13	**7**
55	Spanaway Pipeline	dry_corr	5209652	545580	2	1	0	2	2	1	2	3	0	13	**7**
12	**Dailman Lake**	wet_open	5207677	536734	2	3	0	1	1	1	2	2	0	12	**7**
31	**Nixon Bridge**	wet_edge	5208402	536974	2	2	1	1	0	2	2	2	0	12	**7**
66	Wright Lake	wet_sav	5213514	530438	2	2	0	1	1	2	2	2	0	12	**7**
8	Cat Lake	wet_open	5201702	523847	0	2	2	2	1	0	2	3	0	12	**6**
28	Exeter Springs	wet_edge	5205672	530168	0	2	2	2	0	1	2	2	0	11	**6**
41	Nisqually River power line	wet_edge	5212785	522966	2	2	2	2	0	0	1	2	0	11	**6**
46	RTA Pipeline Corridor	dry_corr	5197568	517196	2	2	0	2	1	0	2	2	0	11	**6**
48	Paintball Pond	wet_edge	5216786	530277	0	3	1	1	1	0	2	3	0	11	**6**
50	Roy Gate Rd PiPo	dry_sav	5209136	535777	2	1	0	2	1	0	2	3	0	11	**6**
23	Muck Creek at AIA - Roy	wet_sav	5205883	533843	1	2	2	1	0	0	2	2	0	10	**6**
26	Muck Crk at Roy Gate	wet_corr	5206715	535318	0	2	2	1	2	1	2	0	0	10	**6**
30	**Sequalitchew Creek**	wet_corr	5217781	528700	1	2	2	2	0	0	2	1	0	10	**6**
62	Vietnam Marsh	wet_edge	5212254	539511	1	3	1	0	1	0	2	2	0	10	**6**
1	507 Ruins bat boxes	dry_sav	5212430	541345	2	1	0	1	1	0	2	2	0	9	**6**
27	**Ranger Lake**	wet_corr	5197890	516395	0	1	0	2	1	1	2	2	0	9	**6**
54	Solo Pt - Sequalitchew Creek	wet_edge	5219409	527419	0	2	0	1	1	1	2	2	0	9	**6**
14	Golf Course	dry_sav	5215210	526053	1	2	1	1	2	0	1	0	0	8	**6**
18	**Johnson Prairie**	dry_edge	5197128	520568	1	1	1	0	1	0	2	2	0	8	**6**
11	CIA Road - Range 25-28	dry_corr	5212601	536464	2	1	0	2	3	0	0	2	0	10	**5**
33	Fianders Lake	wet_open	5199642	523611	0	2	2	2	0	0	2	2	0	10	**5**

Site#	Site Name	Habitat class	Northing	Easting	Hoary bat	Little Brown	Yuma Bat	Calif. Bat	Long-eared	Long-legged	Big Brown	Silver-haired	Town-send's	Site score	Species count
17	**Johnson Marsh - upper**	wet_edge	5211228	539084	1	2	0	2	2	0	0	2	0	9	**5**
43	Nisqually Lake - AIA	wet_open	5208876	528335	0	1	0	2	2	0	2	2	0	9	**5**
45	Pipeline Marsh Batbox	dry_edge	5197873	517320	2	2	0	2	0	0	2	1	0	9	**5**
42	**Nisqually River tank bridge**	wet_corr	5203825	527995	0	2	3	1	0	0	2	1	0	8	**5**
44	Obs. Post 9 access road	dry_sav	5208176	530624	1	0	0	2	1	0	2	2	0	8	**5**
60	**Upper Spanaway Marsh**	wet_open	5215481	540660	2	1	0	0	0	0	2	2	1	8	**5**
19	**Lewis Lake - manual**	wet_open	5203569	532739	0	2	2	1	0	0	1	1	0	7	**5**
39	Nisqually River - TA 16	wet_edge	5201786	531367	0	2	1	0	1	0	2	1	0	7	**5**
61	Upper Spanaway Marsh Rd	dry_corr	5216104	540656	0	1	0	1	2	2	0	1	0	7	**5**
5	Bldg 1210 trees	dry_open	5215056	528610	1	1	1	1	0	0	0	1	0	5	**5**
36	**Fish Hatchery**	wet_open	5208399	525294	1	3	3	0	1	0	0	0	0	8	**4**
22	Muck @ 13th Div. Prairie ford	dry_sav	5208845	539490	1	0	0	2	0	0	2	2	0	7	**4**
52	Sawmill Marsh	dry_sav	5213284	527111	0	2	0	1	0	0	2	2	0	7	**4**
59	Trng. Area 8 - Landing Strip	dry_edge	5213775	540370	3	1	0	1	0	0	0	2	0	7	**4**
10	Chambers Lake	wet_open	5207690	535779	0	2	1	1	0	0	0	2	0	6	**4**
21	MacKay Marsh	wet_sav	5216817	529182	2	2	0	1	0	0	0	1	0	6	**4**
25	Military Museum	dry_open	5216051	529210	1	1	0	0	0	0	3	1	0	6	**4**
47	Pipeline Marsh	wet_edge	5196956	518280	0	1	0	1	0	0	2	2	0	6	**4**
2	8th Ave W corridor	dry_corr	5210836	542340	1	1	0	0	0	0	2	1	0	5	**4**
13	East Gate Batbox Marsh	wet_edge	5209522	537844	0	1	0	1	0	0	2	1	0	5	**4**
20	Lake DeBalon	wet_edge	5212842	537099	2	1	0	0	1	0	1	0	0	5	**4**
56	Squirrel Clearing	dry_edge	5213385	537255	0	1	0	2	0	0	0	1	1	5	**4**
65	Wier Prairie	dry_sav	5195967	522034	0	0	0	1	1	0	1	2	0	5	**4**
6	Munitions storage facility	dry_open	5215446	538209	3	0	0	0	0	0	2	3	0	8	**3**
16	**Johnson Marsh - lower**	wet_sav	5210206	537578	1	0	0	0	0	0	2	2	0	5	**3**
64	Wier Prairie oaks	dry_sav	5195786	521275	0	1	0	2	0	0	2	0	0	5	**3**
51	Yelm RTA	dry_edge	5201598	526391	0	0	0	1	0	0	2	1	0	4	**3**
4	American Lake	wet_open	5217279	531175	1	1	1	0	0	0	0	0	0	3	**3**
7	C5A mockup	dry_open	5211323	532804	1	0	0	1	0	0	0	1	0	3	**3**
15	Hamer Marsh	wet_corr	5217373	529169	0	1	1	1	0	0	0	0	0	3	**3**
Site#	**Site Name**	**Habitat class**	**Northing**	**Easting**	**Hoary bat**	**Little Brown**	**Yuma Bat**	**Calif. Bat**	**Long-eared**	**Long-legged**	**Big Brown**	**Silver-haired**	**Town-send's**	**Site score**	**Species count**

49	Regenburg – Tr. Area 16	dry_open	5203330	531204	0	0	0	0	0	1	1	1	0	3	**3**
53	Shaver Marsh	dry_corr	5208986	536919	0	1	0	1	1	0	0	0	0	3	**3**
67	Wier Prairie-upper	dry_sav	5195645	522006	0	0	0	2	0	0	0	2	0	4	**2**
24	Murray Crk	wet_sav	5217480	534503	0	1	0	2	0	0	0	0	0	3	**2**
57	Sanders Slope AIA	dry_edge	5205620	527293	0	0	0	2	1	0	0	0	0	3	**2**
3	8th Ave Pond	dry_edge	5210840	542280	0	0	0	0	2	0	0	0	0	2	**1**
58	Tr. Area 6 - pine savanna	dry_sav	5210411	534131	0	0	0	1	0	0	0	0	0	1	**1**
63	Weyco clearcut	dry_open	5200911	523927	0	0	0	1	0	0	0	0	0	1	**1**
9	Cemetery parking area	dry_open	5212196	531584	0	0	0	0	0	0	0	0	0	0	**0**
				Score totals	57	90	42	77	42	23	89	94	3		
				Species totals	**37**	**53**	**27**	**53**	**31**	**17**	**47**	**53**	**3**		

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