# Monitoring Giant Garter Snakes in the Natomas Basin: 2003 Results

**By Glenn D. Wylie,[1] Michael L. Casazza, and Lisa L. Martin**

January 2004

---

U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Prepared for:

The Natomas Basin Conservancy

[1]Dixon Field Station
USGS Western Ecological Research Center
6924 Tremont Road
Dixon, CA 95620

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, SECRETARY

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

**The use of firm, trade, or brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.**

---

For additional information, contact:

Center Director
Western Ecological Research Center
U.S. Geological Survey
7801 Folsom Blvd., Suite 101
Sacramento, CA 95826

## INTRODUCTION

The Dixon Field Station of the U.S. Geological Survey, Biological Resources Division, has been studying and monitoring giant garter snakes (*Thamnophis gigas*) in the Natomas Basin area of northern Sacramento County since the 2000 field season in an agreement with The Natomas Basin Conservancy (TNBC). Giant garter snakes are federally and state listed as threatened, and are a priority species within the habitat conservation plan for the Natomas Basin. Our purpose was to develop information on distribution and abundance, habitat use, and demography of giant garter snakes in the Natomas Basin (Basin) and to help develop strategies to properly manage and conserve giant garter snakes in this area of Sacramento and Sutter counties. We specifically surveyed property acquired by TNBC for giant garter snakes as well as continuing our assessment of giant garter snakes in other areas of the Basin. This document is a summary report of our results for 2003.

## METHODS

### Study Sites

Properties owned by TNBC (Figure 1) were acquired from 1999 though 2002 and include the Lucich North and adjacent Frazer tracts in the north part of the Basin abutting the Cross Canal levee, the Bennett North, Bennett South, and Lucich South complex near the Sankey and Powerline road intersection, the Brennan tract in the eastern part of the Basin near Sankey road, the Betts-Kismat-Silva tract in the central eastern part of the Basin, the Ayala property in the central eastern part of the Basin to the south of Elverta Road, the Sills property in the central part of the Basin north of Elverta Road, and the Sousa/Natomas Farms, Cummings and Alleghany 50 properties in the southwest part of the Basin south of Del Paso Road. Although TNBC acquired the Huffman, Atkinson, and Ruby Ranch properties in 2003, we were not asked to survey these properties for giant garter snakes or were officially informed of their acquisition.

In addition to properties owned by the Conservancy, we searched ditches and canals of Reclamation District 1000 and several parcels of private lands (Figure 2). They include the ditch known as “Snake alley” to the north of Elverta Road, a ditch to the west near Highway 99 and an agricultural landing strip (Airstrip), a ditch near Lone Tree Road (Lone Tree), a ditch near Meister Road (Meister), a ditch along Powerline Road (Powerline) continuous with Meister, and a section of the Central Main Canal between Power Line Road and Lone Tree Road.

### Habitat assessment:

Along the trap lines in each study area we documented the type of habitat present as substrate, as a proportion of surface area (water, vegetation, bare ground, etc.) within 1 m of each trap, and vegetation class distribution (classes of aquatic and terrestrial vegetation) within 1 m of each trap. Thus, we first classified the types of substrate present and in what proportion, and then further evaluated the vegetative portion of substrate as to its relative composition (upland, wetland, emergent, etc.) Values were averaged by the total number of traps to characterize a given site and allow for comparison between sites. We also monitored and recorded habitat conditions on nearby fields to evaluate effects of adjacent land use on capture results. In addition

to vegetation characteristics at trap locations, the trap contents of giant garter snake prey items (fish, frogs and tadpoles) were enumerated on a daily basis. To compare sites we calculated average trap contents adjusted for the days the traps were deployed. Water depth, water temperature, and water level fluctuations were also determined daily during the study period.

**Capture**

We used modified floating minnow traps deployed along edges of ditches, canals, and wetland vegetation as our primary source of capture for giant garter snakes (Casazza et al., 2000). We also searched on foot for snakes along the trap locations and in other areas where trapping was not feasible. We used global positioning system (GPS) units to determine the geo-coordinates of trap, search, and capture locations with an error of about 5 meters.

**Measuring and Marking**

Each snake was processed as soon as possible after capture to determine weight, total length, snout to vent length, and sex. Taxonomic features were also quantified such as labial scale counts on the head and dorsal scale counts at mid-body (Rossman et al. 1996). Individuals were implanted with passively induced transponder (PIT) tags for permanent identification. All snakes were released at the point of capture as soon as possible after they were processed.

**Giant Garter Snake Density Estimates**

We used the program CAPTURE to estimate snake densities using two-week sampling intervals when recaptures warranted a density estimates for a sampling area. This relatively short sampling interval should overcome negate effects of an open population. True population estimates are problematic because the populations sampled are assumed to be open (immigration and emigration taking place over time) with a lack of defined population boundaries for many areas. We feel that our mark and recapture results are best applied to the linear distance of the trap lines, and the resulting density can be uses as an index of abundance to evaluate long-term population trends.

## RESULTS

From late April to mid October we captured a total 61 female giant garter snakes and 40 male giant garter snakes for a total of 101 individuals. We recaptured 13 of the females and 9 of the males during the field season. The size frequency distributions of the giant garter snakes are shown in Figures 3 and 4. For comparison we caught 140 snakes in 2002, 31 in 2001 and 81 in 2000.

### Properties of the Natomas Basin Conservancy

### Frazer and Lucich North

We found for the first time a giant garter snake in the Frazer Property in the canal on the east boundary (Table 1). Another snake was reported in the middle of the property by construction crews and positively identified by the site biologist. Disturbance by wetland construction activities on the adjacent Lucich and Frazer properties may have moved snakes into new areas. In the canal on the east Frazer boundary the habitat substrate along the traps was a mix of open water and bare ground followed by terrestrial vegetation. Vegetation was mostly weedy dicots followed by grasses (Figure 5). Total prey density was low with only a few fish present (Table 2). Adjacent field conditions ranged from dry constructed wetlands to flooded emergent rice (Table 3). In the canal on the southeast boundary of Frazer (no captures, Table 1) the habitat substrate along the traps was mostly open water followed by a mix of bare ground, terrestrial vegetation and litter. Vegetation was dominated by weedy dicots (Figure 6). Prey density was low with only a few fish present (Table 2). Adjacent field conditions ranged from dry constructed wetlands to flooded emergent rice (Table 3).

For the adjacent Lucich North property we caught 22 snakes with 6 recaptures in the "t-drain" (Table 1) for a density estimate of 40 snakes/km (95% CI 27-68), which compares closely to the estimate of 32 in 2002 (Wylie et al. 2003). Habitat substrate along the traps was mostly open water followed by terrestrial vegetation. Vegetation was a mix of other wetland vegetation and grasses (Figure 7). Prey density was relatively high with many fish and a few frogs present (Table 2). Adjacent field conditions ranged from dry and fallow to flooded emergent rice (Table 3).

### Bennett North, Bennett South, and Lucich South

For the first time we captured giant garter snakes (two) in the Bennett North property (Table 1). Wetland construction activity near the North Drainage Canal on the east side of the property may have moved snakes further onto the property. Along the traps at Bennett North the habitat substrate was mostly open water followed by a mix of emergent wetland vegetation and bare ground. Vegetation was mostly cattails followed by a mix of other wetland vegetation (Figure 8). Prey density was high with large numbers of tadpoles and many fish present (Table 2). Adjacent field conditions were flooded rice (Table 3).

At Bennett South we caught 26 giant garter snakes with 7 recaptures (Table 1) for a density estimate of 50 (95% CI 35-87), which is similar to the estimate of 45 obtained in 2002 (Wylie et al. 2003). Habitat substrate along the traps was a mix of open water and terrestrial vegetation. Vegetation was mostly grasses and weedy dicots (Figure 9). Prey density was relatively high with several tadpoles and many fish present (Table 2). Adjacent field conditions were flooded rice and constructed wetlands (Table 3). We also trapped the newly-created marshes in Bennett south, but caught no snakes (Table 1). Habitat substrate along the traps was mostly open water followed by a mix of terrestrial and emergent wetland vegetation. Vegetation was mostly other wetland vegetation followed by weedy dicots (Figure 10). Prey density was moderate with several fish present (Table 2). Adjacent habitat was field access roads (Table 3).

At Lucich South we caught 16 giant garter snakes with 4 recaptures (Table 1) for a density estimate of 39 snakes/km (95% CI 28-73), which is less, but not statistically different from, the estimate of 55 in 2002 (Wylie et al. 2003). Habitat substrate along the traps was mostly open water followed by bare ground. Vegetation was mostly weedy dicots followed by a mix of wetland vegetation (Figure 11). Prey density was relatively low with a few frogs, tadpoles and fish present (Table 2). Adjacent field conditions ranged from dry constructed marsh to flooded rice (Table 3).

**Huffman, Atkinson, and Ruby Ranch**

We did not survey these newly-acquired properties in 2003.

**Betts-Kismat-Silva, Ayala, and Sills**

For the first time we captured a giant garter snake in the Betts-Kismat-Silva wetland complex near water control structure K in August (Table 1). We did not catch any other giant garter snakes in other parts of the wetland complex, but did catch giant garter snakes in the ditch bordering the west edge of the property (Table 1). In the west ditch we caught three giant garter snakes in spring and 13 later in the summer and fall for a density estimate of 48 (95% CI 30-98). We caught three giant garter snakes in this ditch in the previous year (Wylie et al. 2003).

The habitat substrate near water control structure K during the spring was a mix of emergent and submergent wetland vegetation, open water, and terrestrial vegetation. The vegetation was an even mix of marsh primrose, other wetland vegetation, weedy dicots, and grasses (Figure 12). Prey density was relatively low in spring with only a few fish present (Table 2). In summer, when we caught the snake, the habitat substrate was mostly emergent wetland vegetation followed by mix of open water and submergent vegetation. Vegetation by summer was mostly marsh primrose (Figure 13). Prey were relatively abundant by summer with many frogs and fish present (Table 2). Adjacent field conditions during summer ranged from dry uplands and roads to flooded wetlands (Table 3). Along the traps in the west ditch in spring the substrate was an even mix of open water and terrestrial vegetation. Vegetation was mostly grasses followed by weedy dicots (Figure 14). Prey density in spring was relatively low with only a few fish and frogs present (Table 2). Adjacent field conditions were dry in spring (Table 3). In summer along the traps in the west ditch the substrate was mostly a mix of open water and

terrestrial vegetation. Vegetation was mostly weedy dicots followed by other wetland vegetation (Figure 15). By summer the prey density had increased to include many frogs, tadpoles and fish (Table 2). Adjacent field conditions in summer were dry upland and flooded rice.

Habitat substrate along the traps near water control structure A (no captures, Table 1) was mostly open water followed by emergent wetland vegetation. Vegetation was mostly other wetland vegetation followed by a mix of marsh primrose, weedy dicots and grasses (Figure 16). Prey density was relatively high with many frogs and fish present (Table 2). Adjacent habitats were uplands and flooded marsh (Table 3). In the marsh near water control structure K (no captures, Table 1) substrate was mostly a mix of terrestrial vegetation, emergent wetland vegetation and open water. Vegetation was a mix of weedy dicots, grasses, and marsh primrose (Figure 17). Prey density was moderate with some frogs, tadpoles and fish present (Table 2). Adjacent habitat was a field road and flooded marsh. In the ditch south of water control structure K (no captures, Table 1) the habitat substrate was a mix of terrestrial vegetation, emergent aquatic vegetation, and open water. The vegetation was an even mix of weedy dicots, grasses, and marsh primrose (Figure 18). Prey density was relatively high with frogs, tadpoles and fish present (Table 2). Adjacent habitat was a road, dry uplands and another ditch (Table 3).

In the Ayala property we did not catch any giant garter snakes, consistent with our findings in 2002 (Wylie et al. 2003). Habitat substrate surrounding traps at the south end of the property were mostly open water followed by a mix of bare ground and terrestrial and emergent vegetation. Vegetation was mostly weedy dicots followed by a mix of grass and miscellaneous wetland vegetation (Figure 19). Prey density was moderate with some frogs and fish present (Table 2). Adjacent field conditions ranged from dry and disked to flooded rice (Table 3). At the east side of the property substrate along the traps was a mix of open water and bare ground. Vegetation was mostly weedy dicots followed by a mix of grasses and miscellaneous wetland vegetation (Figure 20). Prey density was relatively low with some fish present (Table 2). Adjacent field conditions ranged from dry non-rice crops to flooded rice (Table 3).

At Sills ranch we caught 8 giant garter snakes with one recapture along the west end of the property for a density estimate of 19 (95% CI 12-41). In 2002 we caught 6 snakes with no recaptures to make a density estimate for Sills that year (Wylie et al. 2003). Substrate along the traps at the southern end of Sills was mostly open water then bare ground and terrestrial vegetation. Vegetation was dominated by miscellaneous other wetland vegetation followed by grasses and weedy dicots (Figure 21). Prey density was moderate with some frogs, tadpoles and fish present (Table 2). Adjacent habitat conditions were various stages of flooded rice (Table 3). We caught no snakes in a canal on the northern end of the property (Table 1). Substrate along the traps there was mostly open water followed by a mix of emergent wetland and terrestrial vegetation. Vegetation was mostly grasses followed by a mix of other wetland vegetation and weedy dicots (Figure 22). Prey density was low (Table 2). Adjacent habitat conditions were various stages of flooded rice (Table 3). We caught one snake in another trap line on the east side of the property (Table 1). Substrate along the traps there was a mix of open water and terrestrial vegetation. Vegetation was a mix of weedy dicots and grasses (Figure 23). Prey density was relatively high with many frogs, tadpoles and fish present (Table 2). Adjacent field conditions ranged from dry uplands and field roads to flooded rice (Table 3).

**Sousa/Natomas Farms, Cummings, and Alleghany 50**

These properties did not have giant garter snake habitat in 2003. We searched on foot for giant garter snakes near drainage features of these properties several times, but did not encounter any snakes.

## PROPERTIES NOT OWNED BY THE NATOMAS BASIN CONSERVANCY

**Snake Alley and Airstrip**

We caught three giant garter snakes in the canal known as Snake Alley and had no recaptures and, therefore, no density estimate (Table 1). In the same time period in 2002 we caught 24 snakes and had 10 recaptures (Wylie et al 2003). Fallow adjacent field conditions and low water levels in the ditch may have contributed to our low trapping success for Snake Alley in 2003. Substrate along the traps there was mostly open water followed by terrestrial vegetation. Vegetation was dominated by a mix of weedy dicots and grasses (Figure 24). Prey density was low with only a few fish present (Table 2). Adjacent field status during the period of trapping changed from dry and fallow to disked and flooded (Table 3).

In the Airstrip ditch to the west of Snake Alley we caught 15 giant garter snakes and had 1 recapture and no density estimate (Table 1). Over a longer trapping period in 2002 we caught 23 snakes with one recapture at this site (Wylie et al. 2003). Substrate near traps was mostly open water followed by a mix of bare ground and terrestrial vegetation. Vegetation was dominated by a mix of weedy dicots and grasses (Figure 25). Prey density was low with a few frogs, tadpoles and fish present (Table 2). Adjacent field status during the period of trapping changed from dry and fallow to flooded early emergent rice (Table 3).

**Elkhorn and Lone Tree**

We caught no giant garter snakes in the Elkhorn ditch (Table 1), consistent with our findings in 2002 (Wylie et al. 2003). Substrate near the traps there was mostly open water followed by a mix of emergent wetland vegetation and terrestrial vegetation. Vegetation was mostly cattails followed by weedy dicots and grasses (Figure 26). Prey density was low with only a few frogs, tadpoles and fish present (Table 2). Adjacent field conditions were dry and fallow (Table 3).

The northern section of the Lone Tree ditch yielded 1 giant garter snake (Table 1). Substrate along the traps there was mostly open water and terrestrial vegetation. Vegetation was dominated by grasses (Figure 27). Prey density was low with some tadpoles present (Table 2). Adjacent field conditions ranged from dry fallow and disked to flooded rice (Table 3). The central section of the Lone Tree ditch yielded no giant garter snakes (Table 1). Substrate along the traps there was mostly open water followed by a mix of bare ground and terrestrial vegetation. Vegetation was dominated by grasses and weedy dicots (Figure 28). Only one frog was caught in the traps (Table 2). Adjacent field conditions ranged from dry and fallow to various stages of flooded rice (Table 3). The southern section of the Lone Tree ditch yielded no giant garter snakes (Table 1). Substrate near the traps there was mostly open water and

terrestrial vegetation. Vegetation was dominated by weedy dicots followed by grasses (Figure 29). Prey density was low with only a few tadpoles and a fish present (Table 2). Adjacent field conditions ranged from dry uplands to flooded fallow fields (Table 3). Fallowing of land for the proposed development of the Metro Airpark around the Elkhorn and Lone Tree sites seems to have reduced or eliminated giant garter snakes in this area compared to results from our previous work (Wylie et al. 2000).

**Central Main Canal**

We caught a total of eight giant garter snakes in the Central Main Canal (Table 1). We caught four giant garter snakes with one recapture in the mid section of the Central Main Canal northwest of Lone Tree Road for a density estimate of 4 (95% CI 3-13). Substrate near the traps there was mostly open water and bare ground and vegetation was dominated by miscellaneous other wetland vegetation followed by weedy dicots (Figure 30). Prey density was moderate with several tadpoles and fish present (Table 2). Adjacent field conditions were dry and fallow (Table 3). We did not catch any snakes in the mid section to the southeast of Lone Tree Road (Table 1). Substrate near the traps there was mostly open water and bare ground and vegetation was mostly weedy dicots and miscellaneous other wetland vegetation (Figure 31). Prey density was moderate with many fish and a few frogs and tadpoles present (Table 2). Adjacent field conditions were dry and disked and flooded rice (Table 3. We caught 2 giant garter snakes south section of the Central Main Canal (Table 1). Substrate near the traps there was mostly open water followed by emergent and terrestrial vegetation. Vegetation was a mix of weedy dicots and grasses and other wetland vegetation (Figure 32). Prey density was relatively high with many tadpoles and fish present (Table 2). Adjacent field conditions were dry disked and flooded rice (Table 3). We also caught 2 giant garter snakes in the north section of the Central Main Canal. Substrate near the traps there was mostly open water and terrestrial vegetation followed by bare ground. Vegetation was mostly weedy dicots followed by grasses (Figure 33). Prey density was low with only a few tadpoles and fish present (Table 2). Adjacent habitat conditions were fallow fields and Power Line Road (Table 3).

**Meister Road and Power Line Road**

We caught 5 giant garter snakes along the Meister Road ditch with no recaptures (Table 1). In 2002 we caught one snake in this ditch (Wylie et al. 2003). Land is fallow to the north of this site in preparation for development of the Metro Airpark, which may have reduced snake numbers in this ditch compared to results from our previous work (Wylie et al. 2000). Substrate along the Meister Road traps was mostly open water and bare ground. Vegetation was dominated by weedy dicots and grasses (Figure 34). Prey density was moderate with some frogs tadpoles and fish present (Table 2). Adjacent field conditions were dry and fallow (Table 3).

We caught 1 giant garter snake in the contiguous part of this ditch that parallels Power Line road (Table 1), and this was a recapture from the Meister Road site. We have not trapped this Power Line section of the ditch before. Substrate along the Powerline traps was mostly open water followed by litter and bare ground. Weedy dicots dominated the vegetation types (Figure 35). Prey density was moderate with fish and tadpoles present (Table 2). Adjacent habitat conditions were fallow fields and Power Line Road (Table 3).

## DISCUSSION

Late season rains in spring 2003 delayed planting of many rice fields in the Natomas Basin as well as in other parts of the Sacramento Valley rice-growing region. Fields were left fallow often until June and adjacent ditches remained dry during spring because of the delay in demand for irrigation water. We were not able to survey for giant garter snakes at some sites during time periods comparable to previous years because there was no water in which to trap. Overall, giant garter snake captures were down compared to 2002 (101 versus 140) likely because of the delay in irrigation agriculture which limited snake habitat. The combined size class frequencies for 2003 indicate recruitment of young giant garter snakes into the overall population, similar to previous years (Wylie et al. 2003). The phenomena that resulted in few snake captures in 2001 may have produced the bimodal appearance of the length frequencies (length as a surrogate for age) due to the reduction in the middle size classes that may have been representative of the 2001 cohort (Figure 5).

Sample size limitations precluded direct interpretation of the relationship among snake abundance, prey abundance and habitat characteristics. The dry conditions that prevailed early in the season may have overwhelmed other differences among sites. Additional years of habitat sampling are needed to quantify true differences. Also, habitat conditions and prey density change from spring through summer. This is the first year we attempted such habitat characterizations, so a longer sampling period throughout the snake active season to quantifying these habitat characteristics is needed at each site in succeeding years.

Comparison of giant garter snake numbers from year to year was problematic at TNBC sites of Lucich North and Frazer, and to a lesser extent at Bennett North, Bennett South and Lucich South because land use has changed from rice to fallow to active construction of wetlands. Wetland construction is ongoing, and the planned wetlands have yet to be established. It is far too early to evaluate the effects of wetland creation on giant garter snake numbers at these sites. In contrast to these sites, habitat in constructed wetlands at the Betts-Kismat-Silva complex has matured with extensive stands of wetland vegetation and other vegetative cover key in giant garter snake habitat. In particular, the dense growth of marsh primrose in parts of this wetland complex is encouraging because marsh primrose provides important cover in which giant garter snakes thrive at other sites in Colusa National Wildlife Refuge, the Colusa Basin Drain, and Badger Creek (USGS, unpublished data). Indeed, the first giant garter snake caught in the Betts-Kismat-Silva wetland complex was captured in a stand of marsh primrose. The maturation of vegetative cover in the Betts-Kismat-Silva wetlands, the increased numbers of giant garter snakes in the ditch on the west border of the property, and the discovery this year of a giant garter snake within the wetland complex, indicates that giant garter snakes should now rapidly colonize these wetlands, which would be in keeping with our results for Colusa National Wildlife Refuge (Wylie et al. 2002 ). We trapped late in the season at Betts-Kismat-Silva to intensify our search for giant garter snakes. There is a risk of neonates getting stuck in mesh of the traps and drowning, so monitoring with standard traps should not routinely be done later than mid-August. The results from the first three years of giant garter snake surveys in non-TNBC reference habitat show that it will take more years of giant garter snake surveys to estimate "normal" variability of results for giant garter snake captures with which to detect true trends in

snake numbers (Wylie et al. 2003). Fallowing of land does appear to reduce or eliminate our capture success in adjacent  als.

Establishing and improving giant garter snake habitat on TNBC lands should proceed as quickly as practical. Giant garter snakes are the only endemic federally listed species in the Natomas Basin and their habitat is the most directly affected by development in the Basin. Therefore, giant garter snakes should be given top priority for habitat conservation in the Natomas Basin. The level of connectivity between known giant garter snake use areas and newly created wetlands should be considered when designing new projects. Understanding how snakes use the linkages among habitat areas is critical to the successful establishment of giant garter snake populations in restored areas. In addition to the threats to garter snakes posed by land development, programs are in place to purchase water from rice growers to be exported to the south, and these water sales are scheduled to increase. If land fallowed by water sales increases in the Basin and other parts of the Sacramento Valley, the habitat managed by the Conservancy becomes all the more important to protecting snake populations.

In addition to continued monitoring and assessment of giant garter snake response to habitat development in the Natomas Basin, we feel a radio telemetry study is appropriate to assess movements and habitat use in and near constructed wetlands to guide management of these wetlands. Radio telemetry information may allow mangers to better understand how snakes use movement corridors between habitat sites and how those sites may be improved. Also, development projects in the southern end of the Basin will destroy local snake populations, particularly when there is no avenue of escape from construction activity. In these cases the U.S. Fish and Wildlife Service should consider if snakes in these areas of imminent development should be captured in a salvage effort and relocated to TNBC property with suitable habitat. A radio telemetry study to examine how these transplanted snakes adapt to their new locations would help in determining if transplanting within the Basin is a viable conservation measure.

## Literature Cited

Casazza, M. L., G. D. Wylie, and C. J. Gregory. 2000. A funnel trap modification for surface collection of aquatic amphibians and reptiles. Herpetological Review 31(2), 91-92.

Rossman, D. A., N. B. Ford, and R. A. Seigel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman, OK. 332 pp.

Wylie, G. D., M. L. Casazza, L. Martin. 2002. Monitoring giant garter snakes at Colusa National Wildlife Refuge: 2002 results. Progress report to The U.S. Fish and Wildlife Service. USGS-BRD, Dixon, CA. 13 pp.

Wylie, G. D., M. L. Casazza, and L. Martin. 2003. Giant garter snake surveys in the Natomas Basin: 2000-2002. Report to The Natomas Basin Conservancy. USGS-BRD, Dixon, CA. 21 pp.

Table 1. Capture results for giant garter snakes in the Natomas Basin for 2003.

| Trap line location | Total number of captures | Total number of recaptures | Linear Density Estimate (snakes/km) | Trap success rate (snakes/trap day) | Total number of Traps | Total number of trap days | Trap Dates |
|---|---|---|---|---|---|---|---|
| Airstrip | 15 | 1 | * | .008 | 50 | 1750 | 5/14-6/18 |
| Ayala-South end of property | 0 | 0 | * | * | 50 | 700 | 6/12- 6/26 |
| Ayala-East side of property | 0 | 0 | * | * | 50 | 1350 | 6/26-7/24 |
| Bennett North | 2 | 0 | * | .001 | 50 | 1750 | 6/17-7/21 |
| Bennett South-West side and north east corner | 26 | 7 | 50 (95% C.I. 35-87) | .031 | 40 | 840 | 6/30-7/21 |
| Bennett South newly created marsh | 0 | 0 | * | * | 50 | 700 | 8/7-8/21 |
| BKS-Near water control structure **A** | 0 | 0 | * | * | 20 | 480 | 4/25-5/20 |
| BKS-Canal running N/S near water control structure **K** | 0 | 0 | * | * | 40 | 1040 | 4/23-5/20 |
| BKS-Canal running N/S near water control structure **K** | 1 | 0 | * | .0003 | 49 | 3430 | 8/8-10/17 |
| BKS-Marsh near water control structure **K** | 0 | 0 | * | * | 37 | 962 | 8/22-9/17 |
| Dewitt Property, canal south of water control structure **K** | 0 | 0 | * | * | 6 | 90 | 6/23-7/8 |
| BKS-Marsh near water control structure **R** | 0 | 0 | * | * | 40 | 880 | 5/20-6/11 |
| BKS-Marsh near water control structure **R** | 0 | 0 | * | * | 28 | 1540 | 8/20-10/14 |
| BKS-Canal on West property boundary | 3 | 0 | * | .002 | 50 | 1300 | 5/15-6/19 |
| BKS-Canal on West property boundary | 13 | 4 | 48 (95% C.I. 30-98) | .005 | 50 | 2700 | 8/21-10/14 |

Table 1. (Continued).

| Trap line location | Total number of captures | Total number of recaptures | Linear Density Estimate (snakes/km) | Trap success rate (snakes/trap day) | Total number of Traps | Total number of trap days | Trap Dates |
|---|---|---|---|---|---|---|---|
| Central Main Canal- Mid section north-west of Lone Tree Rd. | 4 | 1 | 4 (95% C.I. 3-13) | .003 | 50 | 1450 | 6/24-7/23 |
| Central Main Canal- Mid section South-East of Lone Tree Rd. | 0 | 0 | * | * | 50 | 1100 | 7/1-7/23 |
| Central Main Canal- Southern most portion | 2 | 0 | * | .003 | 50 | 700 | 7/23-8/6 |
| Central Main Canal- Northern most portion | 2 | 0 | * | .002 | 50 | 850 | 7/22-8/8 |
| Elkhorn | 0 | 0 | * | * | 50 | 700 | 6/16-7/1 |
| Frazer-Canal on East property boundary | 1 | 0 | * | .0005 | 50 | 1750 | 6/19-7/24 |
| Frazer-Canal on South/East property boundary | 0 | 0 | * | * | 39 | 507 | 8/7-8/20 |
| Canal running adjacent **Lone Tree Rd**. central section | 0 | 0 | * | * | 50 | 700 | 6/10-6/24 |
| Canal running adjacent **Lone Tree Rd**. north section | 1 | 0 | * | .001 | 50 | 750 | 7/24-8/8 |
| Canal running adjacent **Lone Tree Rd**. south section | 0 | 0 | * | * | 40 | 640 | 7/21-8/6 |
| Lucich North | 22 | 6 | 40 (95% C.I. 27-68) | .012 | 50 | 1800 | 5/12-6/17 |
| Lucich South | 16 | 4 | 39 (95% C.I. 28-73) | .008 | 50 | 1900 | 5/9-6/16 |

Table 1. (Continued).

| Trap line location | Total number of captures | Total number of recaptures | Linear Density Estimate (snakes/km) | Trap success rate (snakes/trap day) | Total number of Traps | Total number of trap days | Trap Dates |
|---|---|---|---|---|---|---|---|
| Canal running parallel to east end of **Meister Rd**. | 5 | 0 | * | .003 | 50 | 1450 | 5/21-6/19 |
| Canal running along **Powerline Rd**., | 1 | 0 | * | .002 | 37 | 1073 | 5/21-6/19 |
| Sills Ranch-Canal on west side of southern end of property. | 8 | 1 | 19 (95% C.I. 12-41) | .004 | 50 | 2100 | 6/10-7/22 |
| Sills Ranch-Canal on East end of North property boundary | 0 | 0 | * | * | 50 | 700 | 6/18-7/2 |
| Sills Ranch-Canal mid-property on East side | 1 | 0 | * | .001 | 50 | 1000 | 7/2-7/22 |
| Canal known as Snake Alley | 3 | 0 | * | .003 | 50 | 1100 | 5/19-6/10 |

Table 2. Giant garter snake prey as sampled by traps.

| **Trap line Name** | Number of Frogs caught | **Frog Density** (frogs/# traps* days trapped) | Number of Tadpoles caught | **Tadpole Density** (tadpoles/# traps* days trapped) | Number of Fish caught | **Fish Density** (fish/# traps* days trapped) | | **Total Prey Density** (total prey/# traps* days trapped) |
|---|---|---|---|---|---|---|---|---|
| Airstrip | 2 | .0011 | 8 | .0046 | 3 | .0017 | | .0074 |
| Ayala- South end of property | 2 | .0029 | 0 | * | 9 | .0129 | | .0137 |
| Ayala- East side of property | 0 | * | 0 | * | 9 | .0067 | | .0067 |
| Bennett North | 0 | | 42 | .024 | 23 | .0131 | | .0371 |
| Bennett South | 2 | .0023 | 12 | .0142 | 40 | .0476 | | .0643 |
| Bennett South- newly created marsh | 0 | * | 0 | * | 19 | .0271 | | .0271 |
| BKS- near water control structure **A** | 25 | .0520 | 0 | | 220 | .4583 | | .5104 |
| BKS-Canal running N/S near water control structure **K** | 0 | * | 0 | * | 8 | .0077 | | .0077 |
| BKS-Canal running N/S near water control structure **K** | 107 | .0312 | 0 | * | 136 | .0397 | | .0708 |
| BKS-Marsh near water control structure **K** | 14 | .0146 | 1 | .0010 | 8 | .0083 | | .0239 |

Table 2 (continued). Giant garter snake prey as sampled by traps.

| **Trap line Name** | Number of Frogs caught | **Frog Density** (frogs/# traps* days trapped) | Number of Tadpoles caught | **Tadpole Density** (tadpoles/# traps* days trapped) | Number of Fish caught | **Fish Density** (fish/# traps* days trapped) | | **Total Prey Density** (total prey/# traps* days trapped) |
|---|---|---|---|---|---|---|---|---|
| Dewitt Property, canal south of water control structure **K** | 20 | .2222 | 4 | .0444 | 10 | .1111 | | .3778 |
| BKS-Marsh near water control structure **R** | 10 | .0114 | 0 | * | 11 | .0125 | | .0239 |
| BKS-Marsh near water control structure **R** | 5 | .0032 | 2 | .0013 | 250 | .0162 | | .1669 |
| BKS- Canal on West property boundary | 3 | .0023 | 0 | * | 6 | .0046 | | .0069 |
| BKS- Canal on west property boundary | 30 | .0111 | 12 | .0044 | 157 | .0581 | | .0737 |
| Central Main Canal- midsection north-west of Lone Tree Rd. | 0 | * | 28 | .0193 | 15 | .0103 | | .0297 |
| Central Main Canal- midsection south-east of Lone Tree Rd. | 2 | .0018 | 2 | .0018 | 31 | .0282 | | .0318 |

Table 2 (continued). Giant garter snake prey as sampled by traps.

| **Trap line Name** | Number of Frogs caught | **Frog Density** (frogs/# traps* days trapped) | Number of Tadpoles caught | **Tadpole Density** (tadpoles/# traps* days trapped) | Number of Fish caught | **Fish Density** (fish/# traps* days trapped) | | **Total Prey Density** (total prey/# traps* days trapped) |
|---|---|---|---|---|---|---|---|---|
| Central Main Canal- Southern most end | 0 | * | 28 | .0400 | 15 | .0214 | | .0614 |
| Central Main Canal- Northern most end | 0 | * | 2 | .0029 | 4 | .0057 | | .0100 |
| Canal North of Elkhorn east of Powerline | 1 | .0014 | 2 | .0029 | 4 | .0057 | | .0100 |
| Frazer- Canal on East property boundry | 0 | * | 0 | * | 3 | .0017 | | .0017 |
| Frazer- Canal on south-east property boundry | 1 | .0020 | 0 | * | 2 | .0039 | | .0059 |
| Canal running adjacent **Lone Tree Rd**. north of Elkhorn Blvd. south of the Central Main Canal | 1 | .0014 | 0 | * | 0 | * | | .0014 |

Table 2 (continued). Giant garter snake prey as sampled by traps.

| **Trap line Name** | Number of Frogs caught | **Frog Density** (frogs/# traps* days trapped) | Number of Tadpoles caught | **Tadpole Density** (tadpoles/# traps* days trapped) | Number of Fish caught | **Fish Density** (fish/# traps* days trapped) | | **Total Prey Density** (total prey/# traps* days trapped) |
|---|---|---|---|---|---|---|---|---|
| Canal running adjacent **Lone Tree Rd**. north of Central Main Canal | 0 | * | 8 | .0107 | 0 | * | | .0107 |
| Canal running adjacent Bird Farm, south of Elkhorn and south of **Lone Tree Rd**. | 0 | * | 7 | .0109 | 1 | .0016 | | .0125 |
| Lucich North | 3 | .0017 | 0 | * | 37 | .0206 | | .0222 |
| Lucich South | 2 | .0011 | 2 | .0011 | 7 | .0037 | | .0058 |
| Canal running parallel to east end of **Meister Rd.** | 1 | .0007 | 1 | .007 | 22 | .0151 | | .0166 |
| Canal running adjacent **Powerline Rd.**, south of Elkhorn Blvd. | 0 | * | 8 | .0075 | 22 | .0205 | | .0280 |

Table 2 (continued). Giant garter snake prey as sampled by traps.

| **Trap line Name** | Number of Frogs caught | **Frog Density** (frogs/# traps* days trapped) | Number of Tadpoles caught | **Tadpole Density** (tadpoles/# traps* days trapped) | Number of Fish caught | **Fish Density** (fish/# traps* days trapped) | | **Total Prey Density** (total prey/# traps* days trapped) |
|---|---|---|---|---|---|---|---|---|
| Sills Ranch-Canal on west side of southern end of property. | 2 | .0010 | 17 | .0081 | 4 | .0019 | | .0110 |
| Sills Ranch-Canal on east end of north property boundary | 0 | * | 1 | .0014 | 1 | .0014 | | .0029 |
| Sills Ranch-Canal mid-property on east side | 6 | .0060 | 28 | .0280 | 47 | .0047 | | .0810 |
| Canal known as Snake Alley | 0 | * | 0 | * | 9 | .0082 | | .0082 |

Table 3. Water status and habitat status of land adjacent to the trap lines.

| Study Site | Water Status | Habitat Status |
|---|---|---|
| Airstrip | dry, puddled, flooded | fallow, disked, early emergent rice |
| Ayala- south end of property | dry, flooded | disked, early emergent rice |
| Ayala- east side of property | dry, flooded, puddled | crop/non-rice, early emergent rice, disked, fully emergent rice |
| Bennett North | flooded, puddle, | early emergent rice, fully emergent rice |
| Bennett South- west side and north east corner | flooded, | fully emergent rice |
| Bennett South- newly made marsh | Roads | roads |
| BKS-near water control structure **A** | dry, flooded | wetlands, upland field |
| BKS- canal running N/S near water control structure **K** | flooded, dry, puddled | upland pasture, wetlands, road |
| BKS- canal running N/S near water control structure **K** | dry, flooded, | road, wetlands, dry upland pasture |
| BKS-marsh near water control structure **K** | dry, flooded | road, wetlands |
| Dewitt Property, canal south of water control structure **K** | dry, flooded | road, upland field, drainage ditch |
| BKS- marsh near water control structure **R** | dry, flooded | upland, wetlands |
| BKS- marsh near water control structure **R** | dry, flooded | road, fully emergent rice |
| BKS- canal on west property boundary | dry | upland, |
| BKS- canal on west property boundary | dry, water being drawn out of rice, puddled | upland, fully emergent rice. |

Table 3 (continued). Water status and habitat status of land adjacent to the trap lines.

| Study Site | Water Status | Vegetation Status |
|---|---|---|
| Central Main Canal- midsection north-west of Lone Tree Rd. | dry | fallow field |
| Central Main Canal- midsection south-east of Lone Tree Rd. | dry, flooded | disked, fully emergent rice |
| Central Main Canal- southern most end | dry, flooded | disked, fully emergent rice |
| Central Main Canal- northern most end | dry, Powerline Rd. | fallow field, Powerline Rd. |
| Canal North of Elkhorn east of Powerline | dry, | fallow field |
| Frazer- canal on East property boundary | dry, flooded, puddled | newly constructed marsh channels, early emergent rice, fully emergent rice |
| Frazer- canal on south-east property boundary | dry, flooded | no vegetation- newly constructed marsh channels, early emergent rice |
| Canal running adjacent **Lone Tree Rd**. North of Elkhorn Blvd. South of the Central Main Canal | dry, flooded, puddled | fallow, disked, early emergent rice, fully emergent rice. |
| Canal running adjacent **Lone Tree Rd**. North of Central Main Canal | dry, flooded | fallow, fully emergent |
| Canal running adjacent Bird Farm, south of Elkhorn and south of **Lone Tree Rd**. | dry, flooded | upland pasture, BirdFarm homestead, fallow filled |
| Lucich North | dry, puddled, flooded | fallow field, early emergent rice, fully emergent rice |
| Lucich South | dry, puddled, flooded | disked, newly constructed marsh channels, early emergent rice |
| Canal running parallel to east end of **Meister Rd.** | dry | fallow |

Table 3. (continued). Water status and habitat status of land adjacent to the trap lines.

| Study Site | Water Status | Vegetation Status |
|---|---|---|
| Canal running adjacent **Powerline Rd.**, south of Elkhorn Blvd. | dry | crop/non-rice, Powerline Rd. |
| Sills Ranch- canal on west side of southern end of property. | dry, puddled, flooded | early emergent rice, fully emergent rice |
| Sills Ranch- canal on east end of north property boundary | puddle, flooded | early emergent rice, fully emergent rice |
| Sills Ranch- canal mid-property on east side | dry, puddled, flooded | upland field, road, fully emergent |
| Canal known as Snake Alley | dry, puddled, flooded | fallow field, disked |

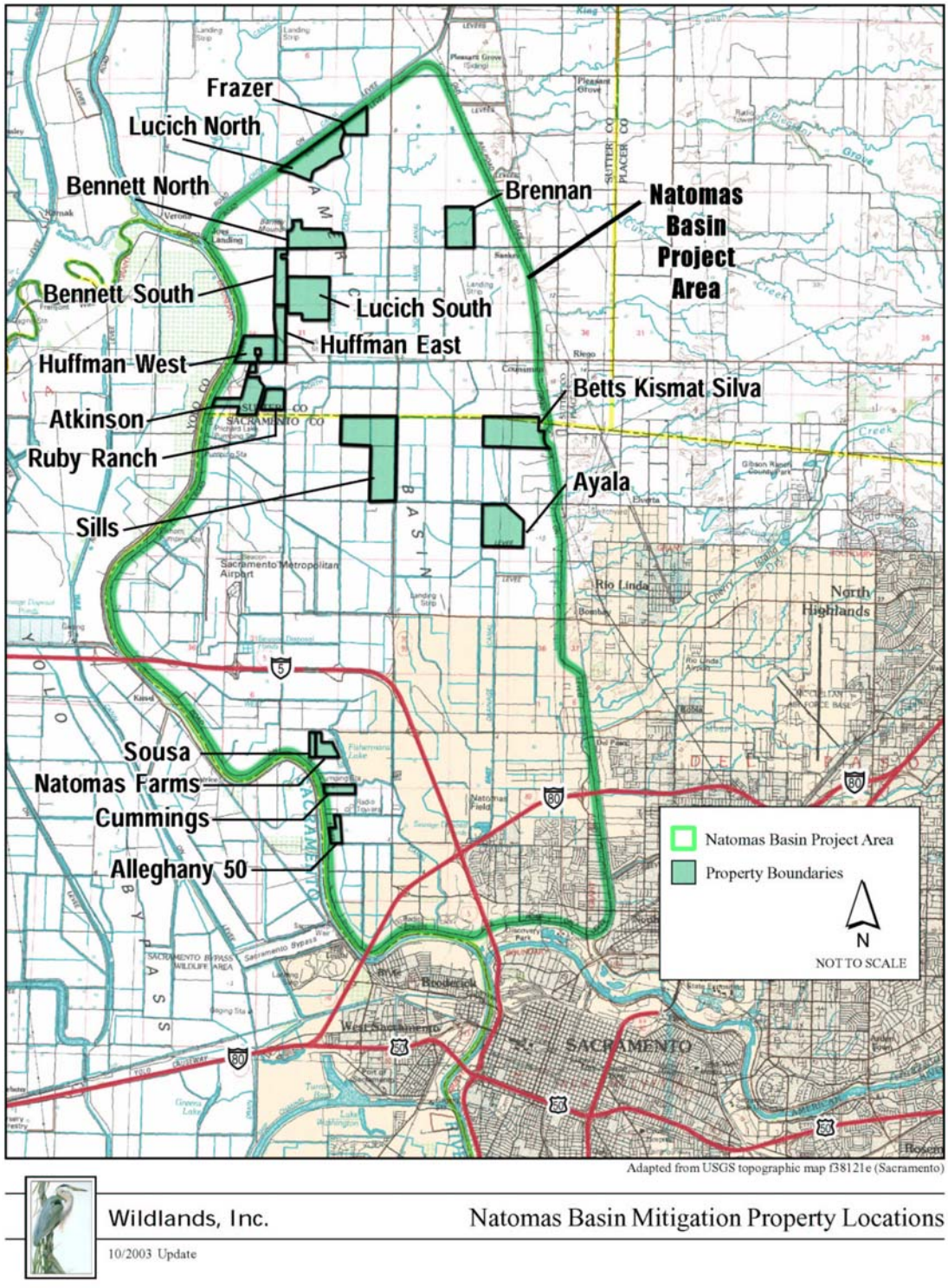



Figure 1. Natomas Basin Conservancy Properties.

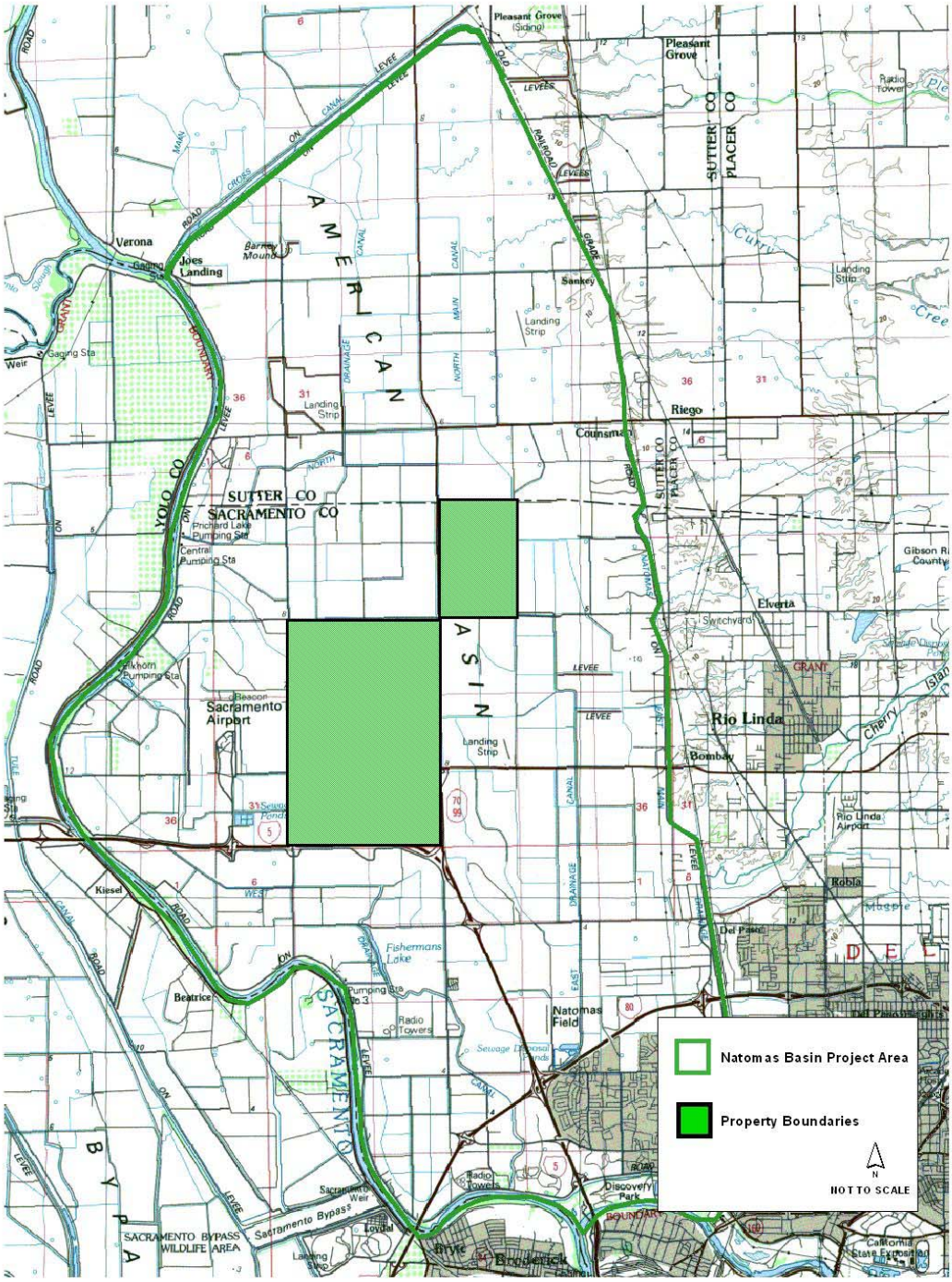



Figure 2. Non-Natomas Basin Conservancy areas searched for giant garter snakes.

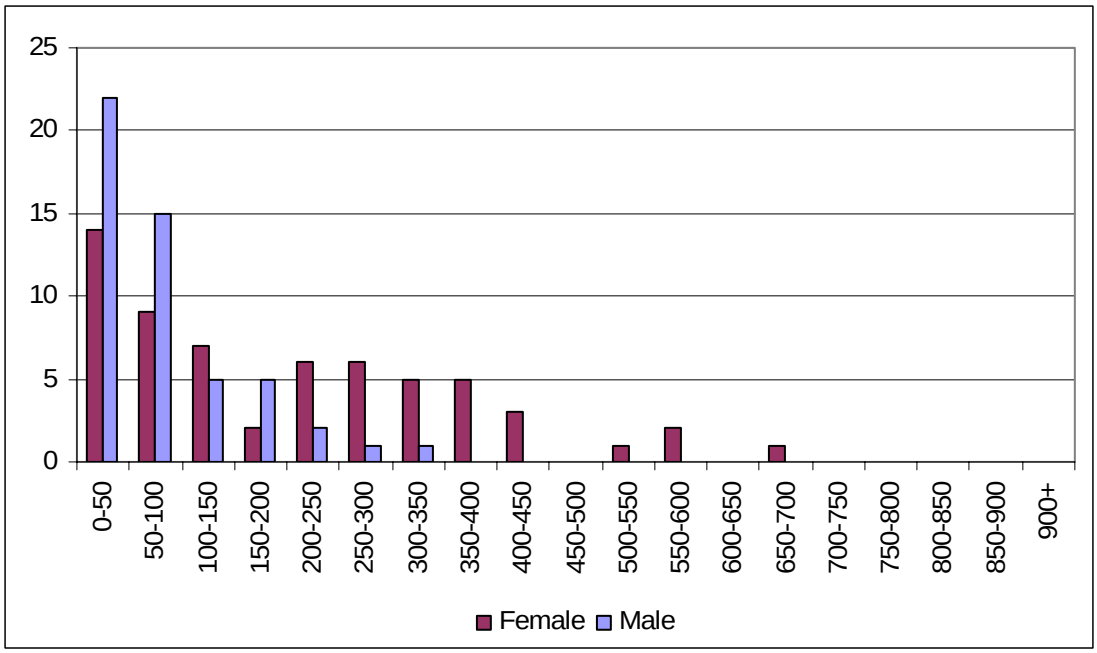



Figure 3. Weight frequency histogram (g) of giant garter snakes captured in the Natomas Basin in 2003.

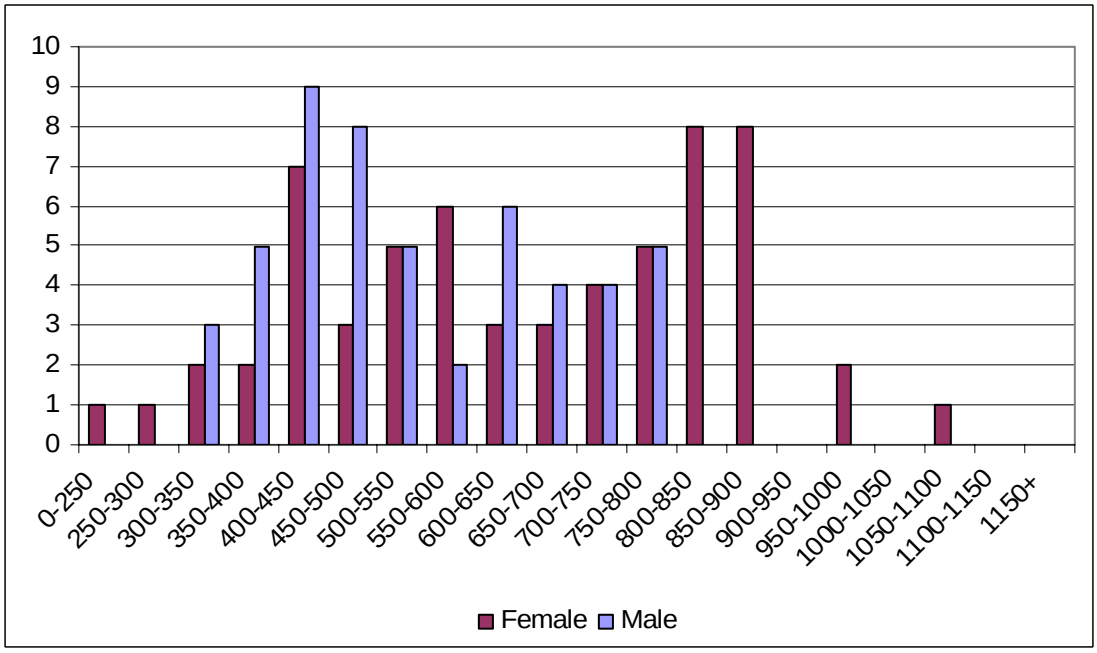



Figure 4. Length frequency histogram (SVL, mm) of giant garter snakes captured in the Natomas Basin in 2003.

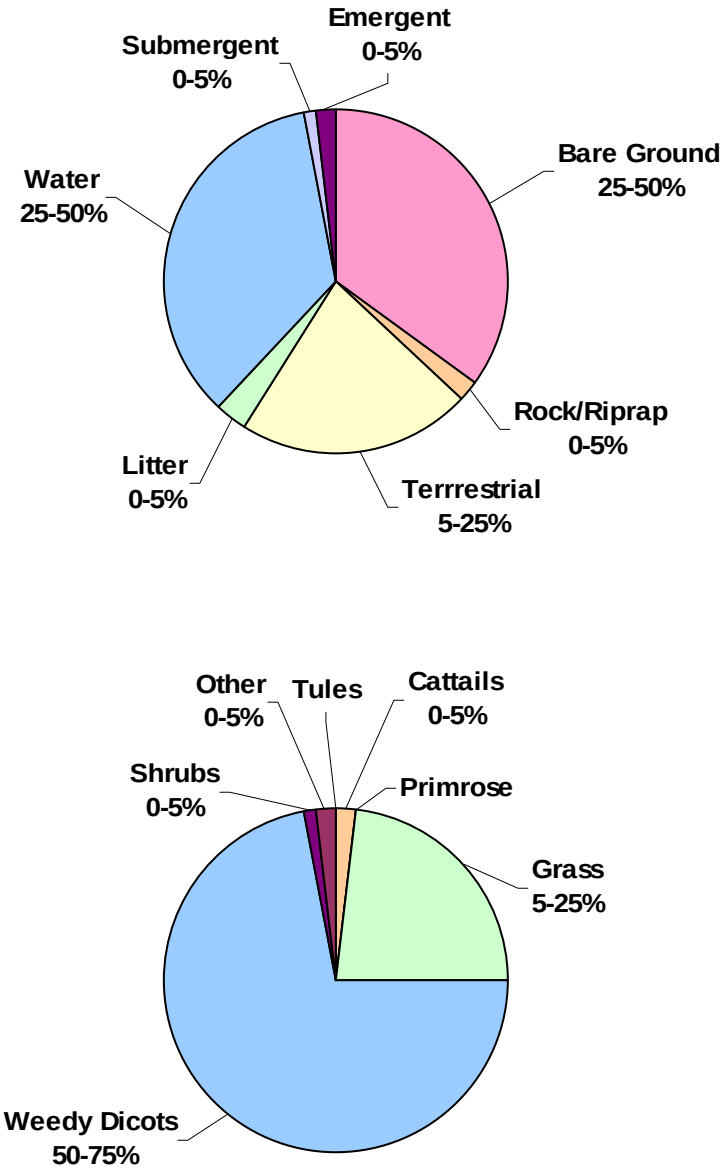



Figure 5. Substrate and vegetative characteristics of the trap line in the canal on the east boundary of Frazer.

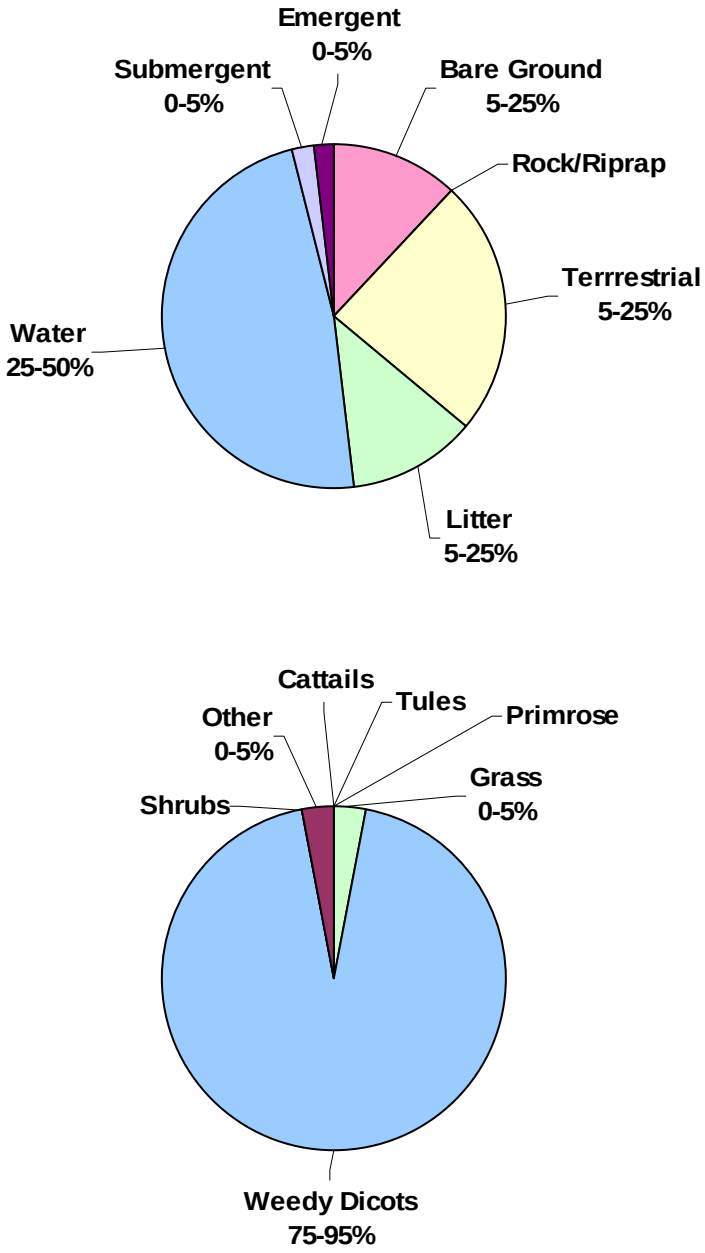



Figure 6. Substrate and vegetative characteristics of the trap line in the canal on the southeast property boundary of Frazer.

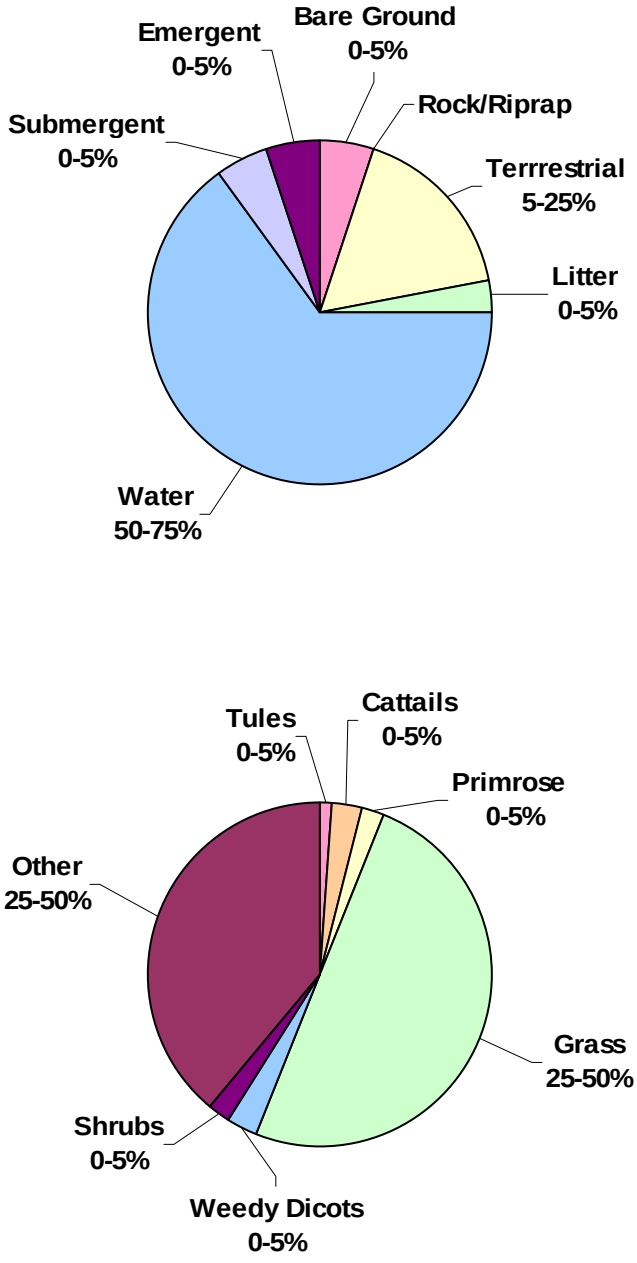



Figure 7. Substrate and vegetative characteristics of the trap line in the "t-drain" on the southern boundary of Lucich North.

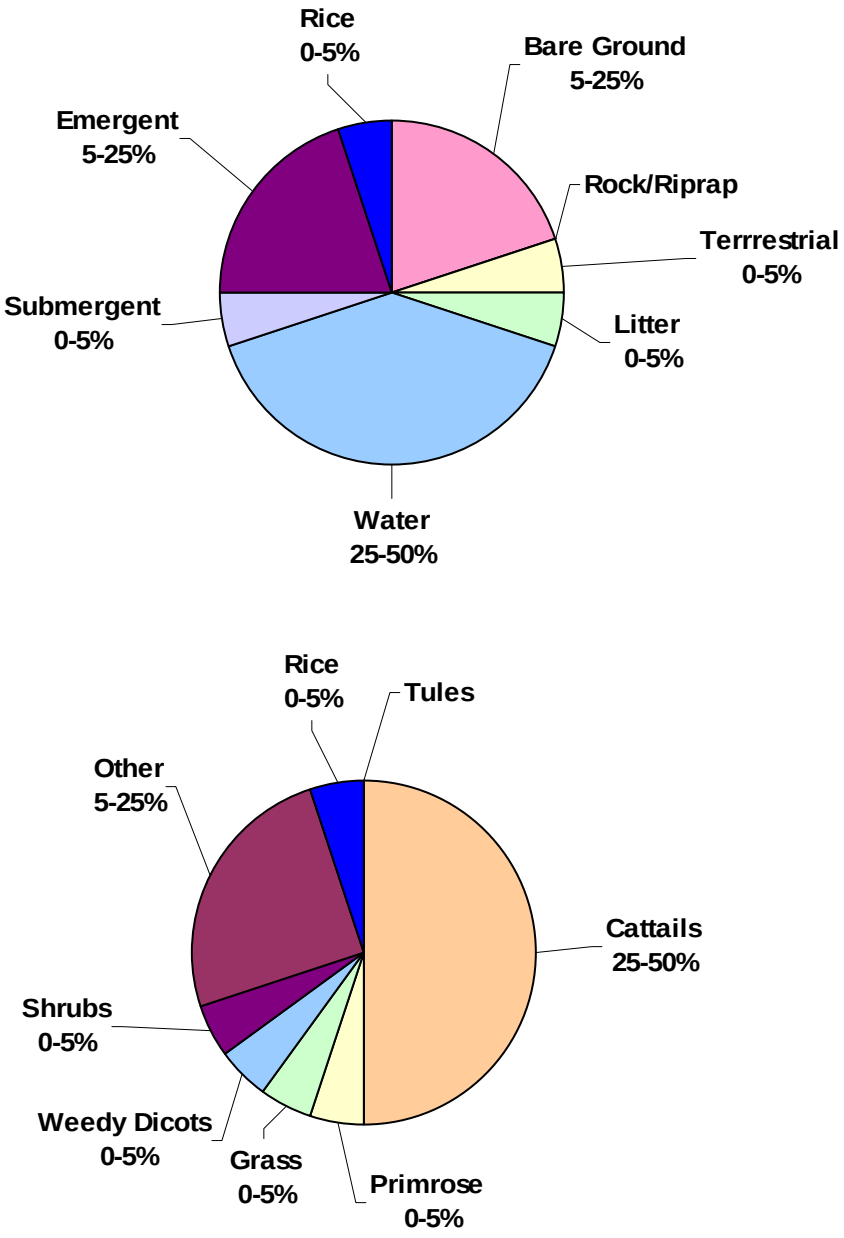



Figure 8. Substrate and vegetative characteristics of the trap line at Bennett North.

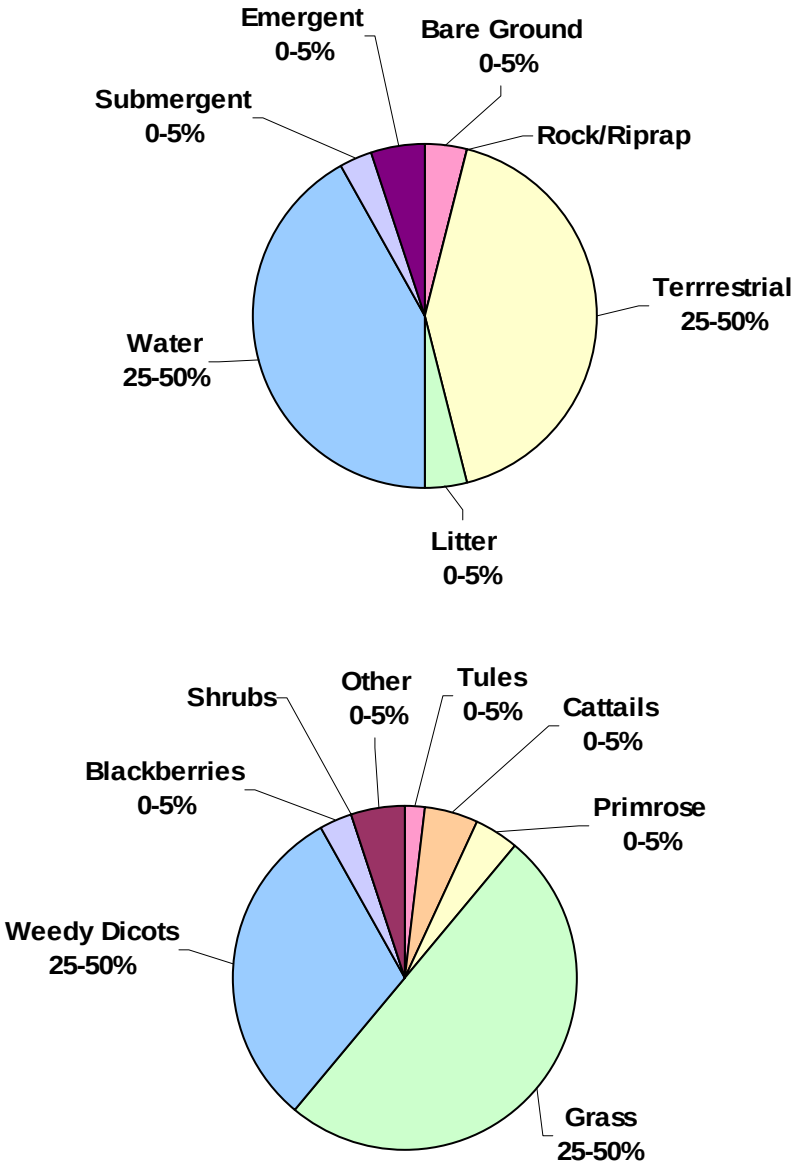



Figure 9. Substrate and vegetative characteristics of the trap line at Bennett South.

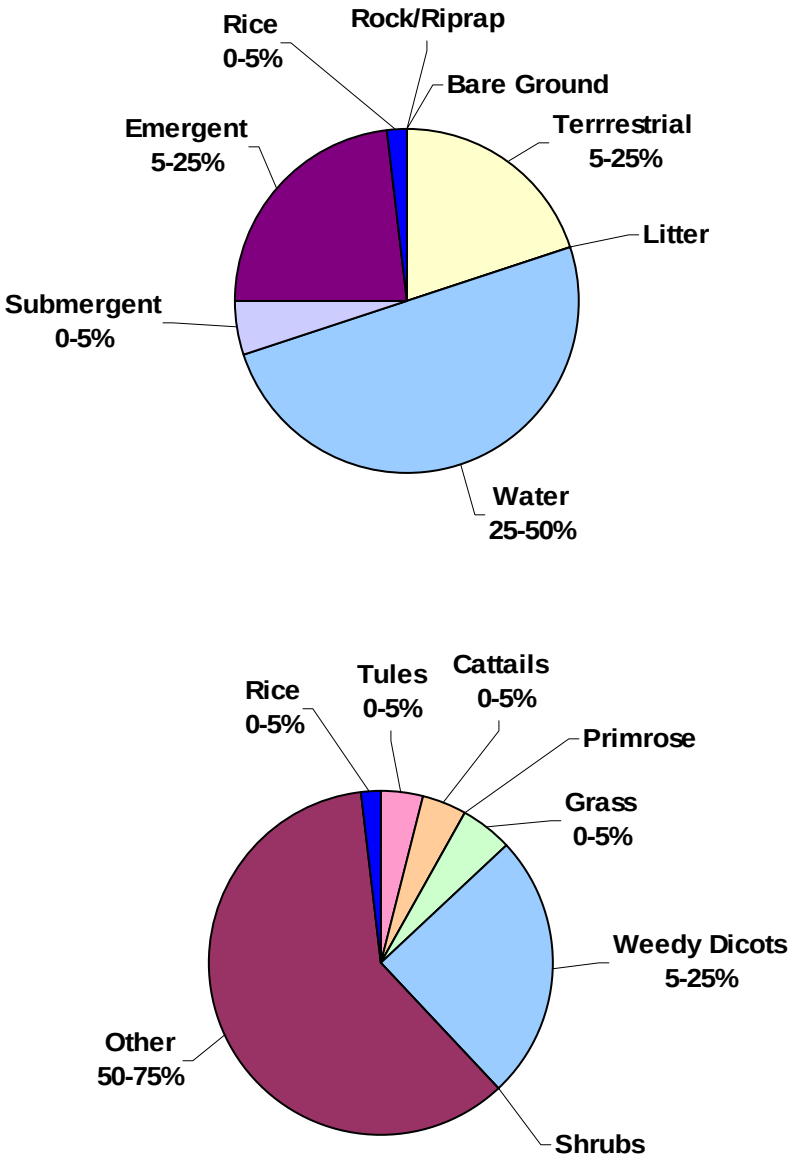



Figure 10. Substrate and vegetative characteristics of the trap line in wetlands of Bennett South.

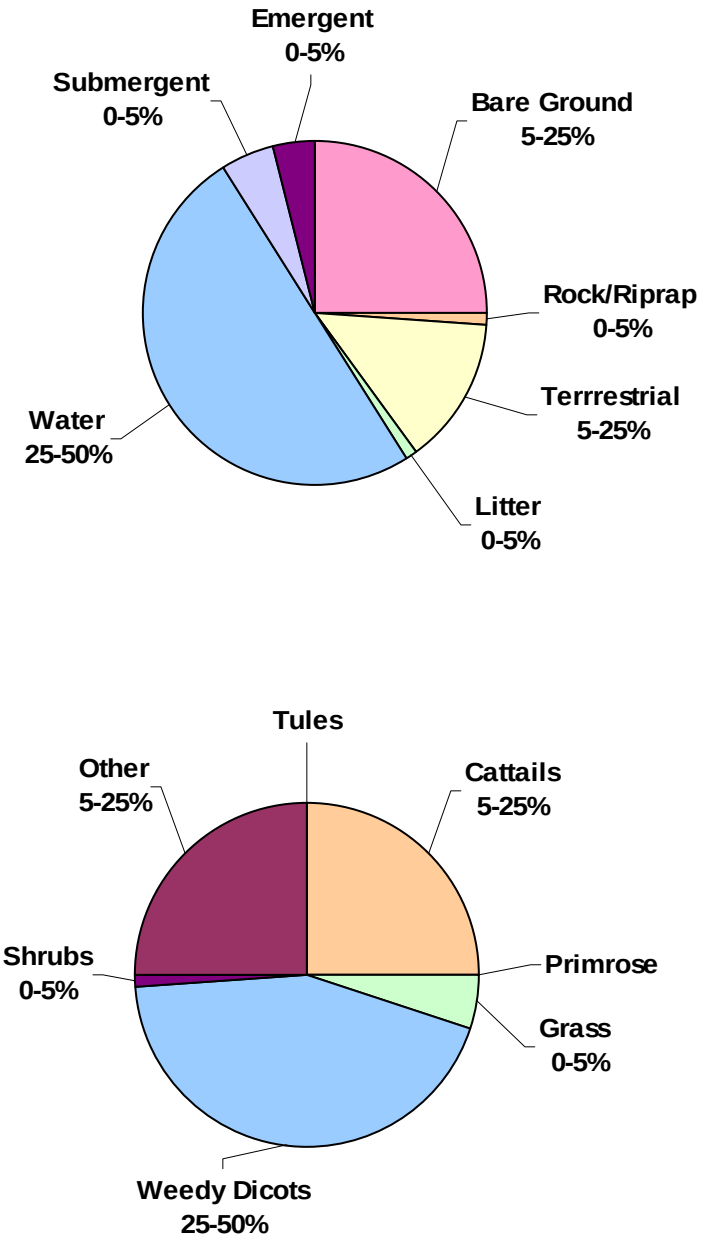



Figure 11. Substrate and vegetative characteristics of the trap line in Lucich South.

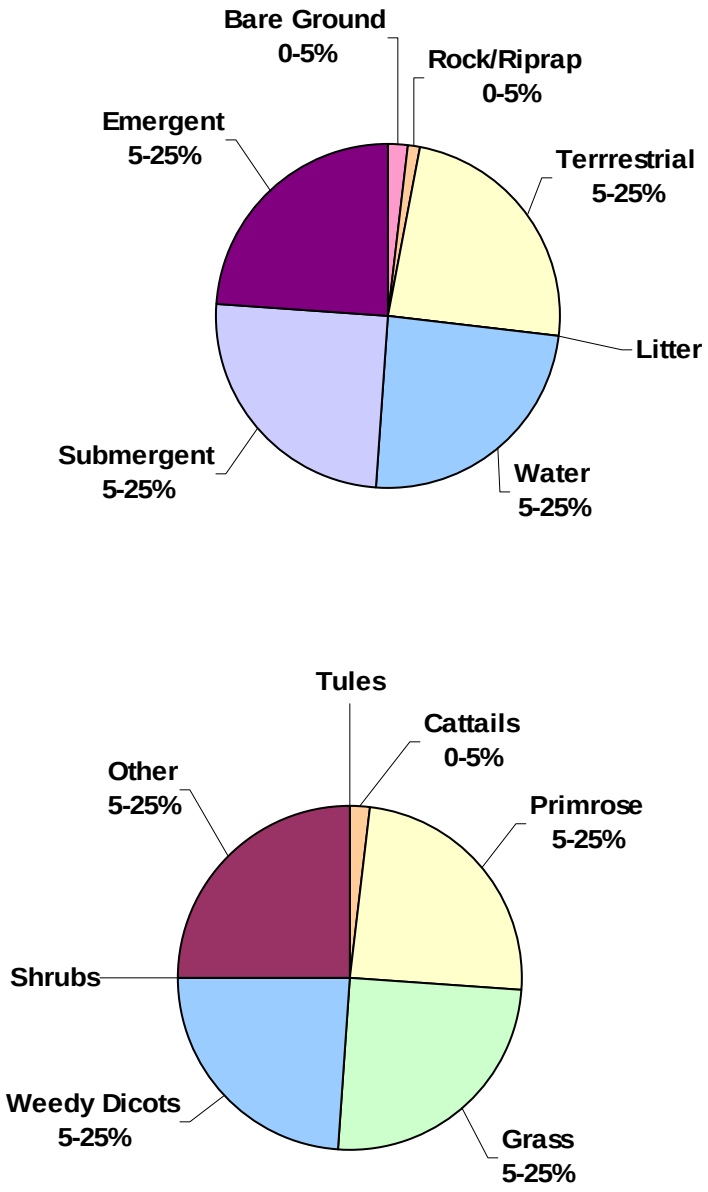



Figure 12. Substrate and vegetative characteristics of the trap line in Betts-Kismat-Silva in the ditch near water control structure K (spring).

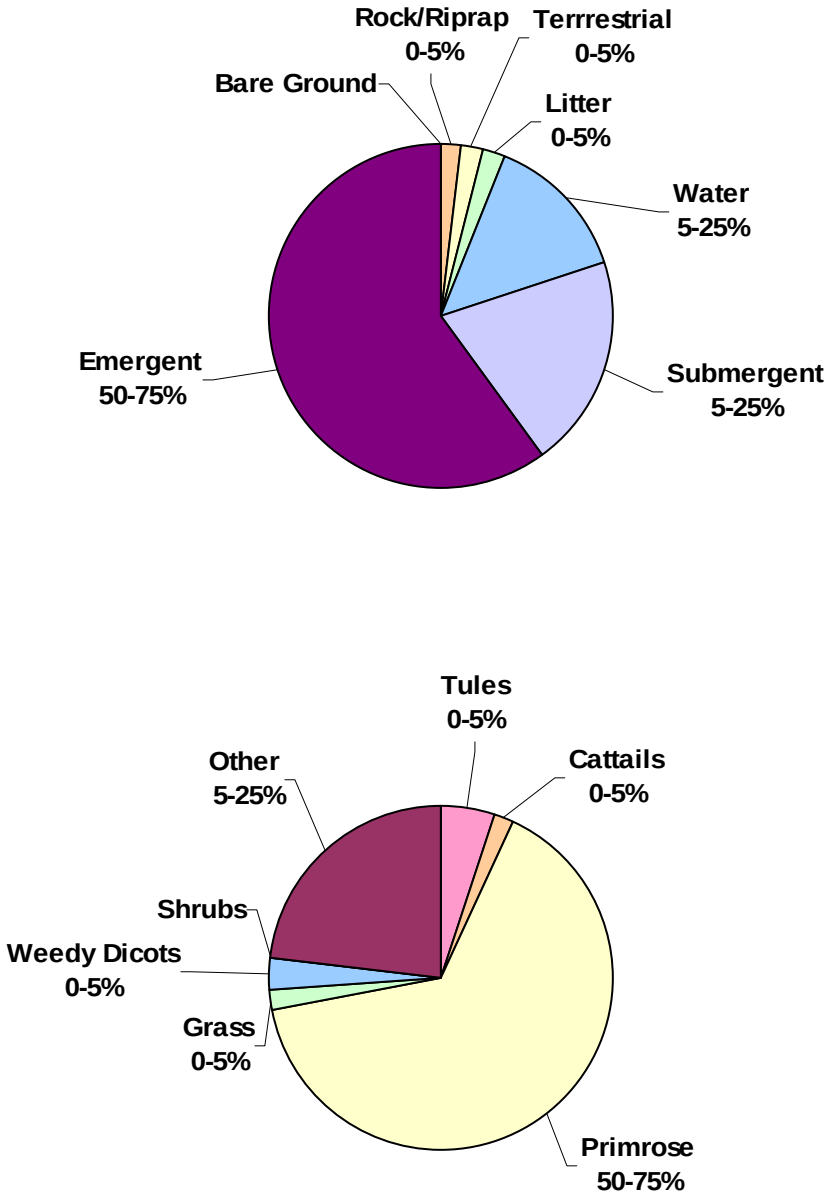



Figure 13. Substrate and vegetative characteristics of the trap line in Betts-Kismat-Silva in the ditch near water control structure K (summer/fall).

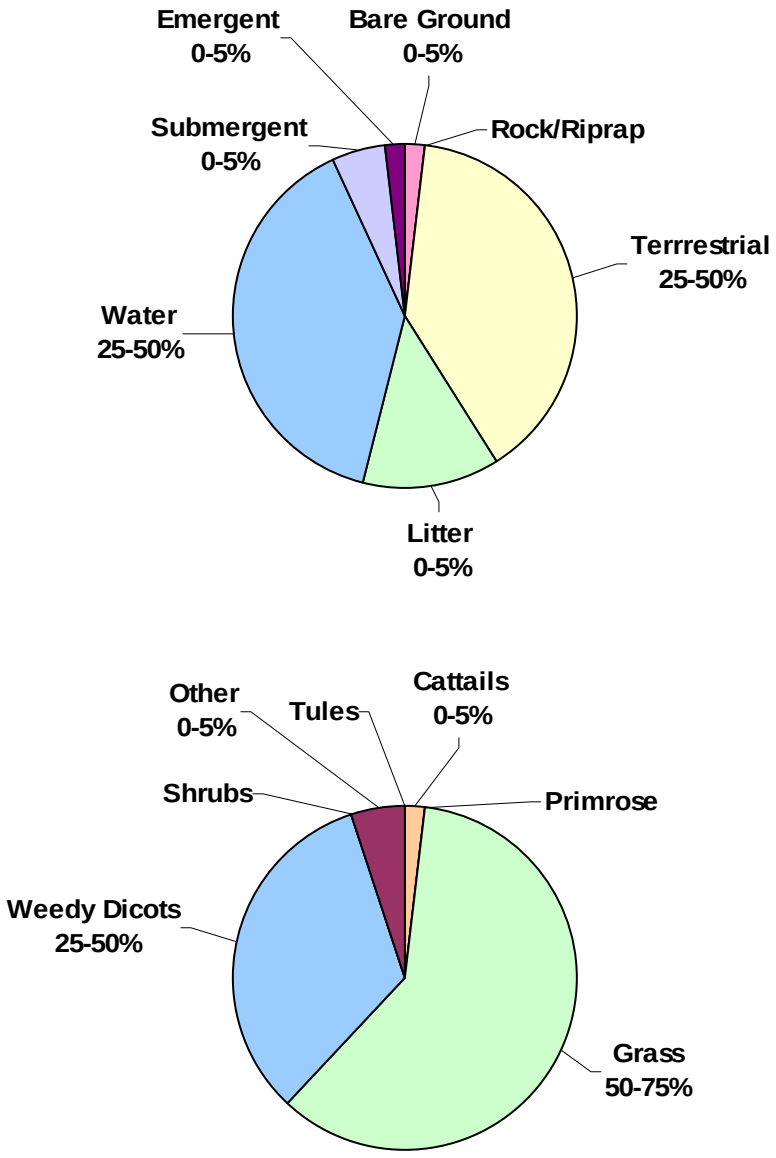



Figure 14. Substrate and vegetative characteristics of the trap line in Betts-Kismat-Silva in the canal on the west boundary (spring).

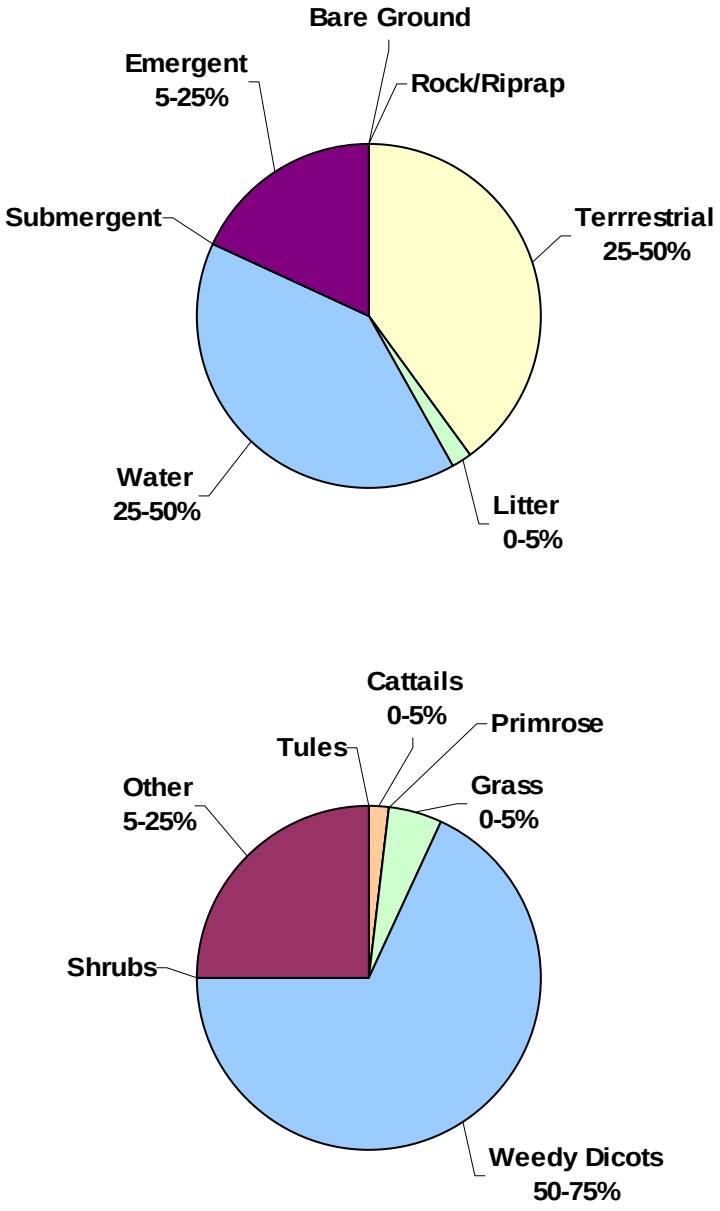



Figure 15. Substrate and vegetative characteristics of the trap line in Betts-Kismat-Silva in the ditch on the west boundary (summer/fall).

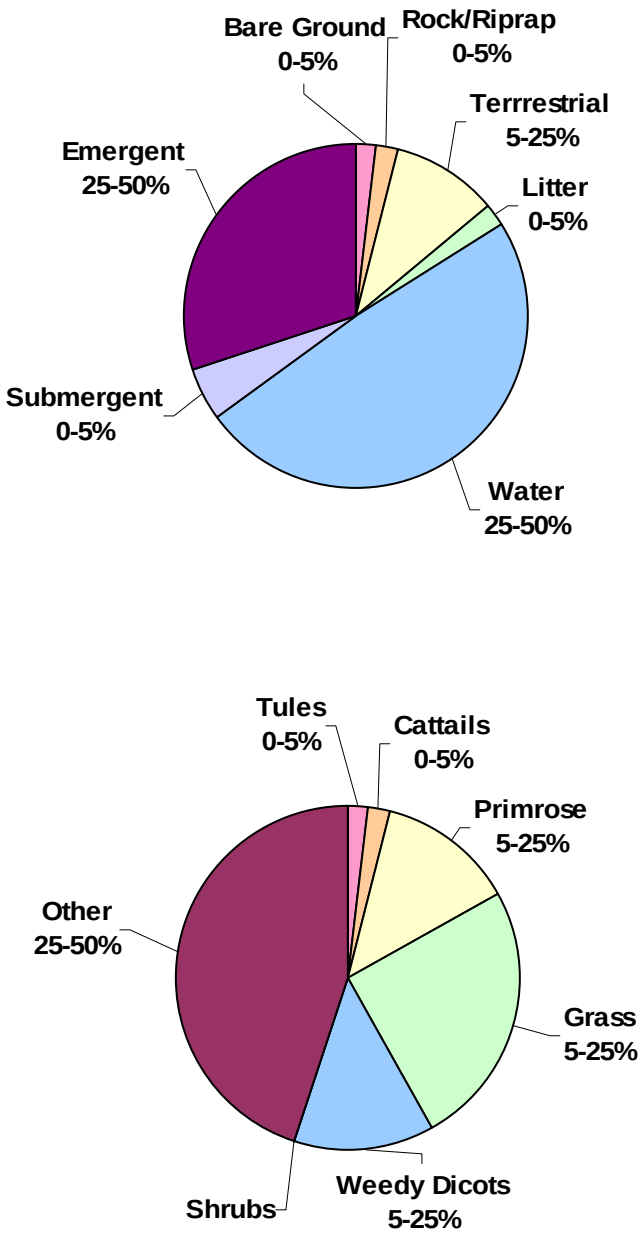



Figure 16. Substrate and vegetative characteristics of the trap line in Betts-Kismat-Silva near water control structure A.

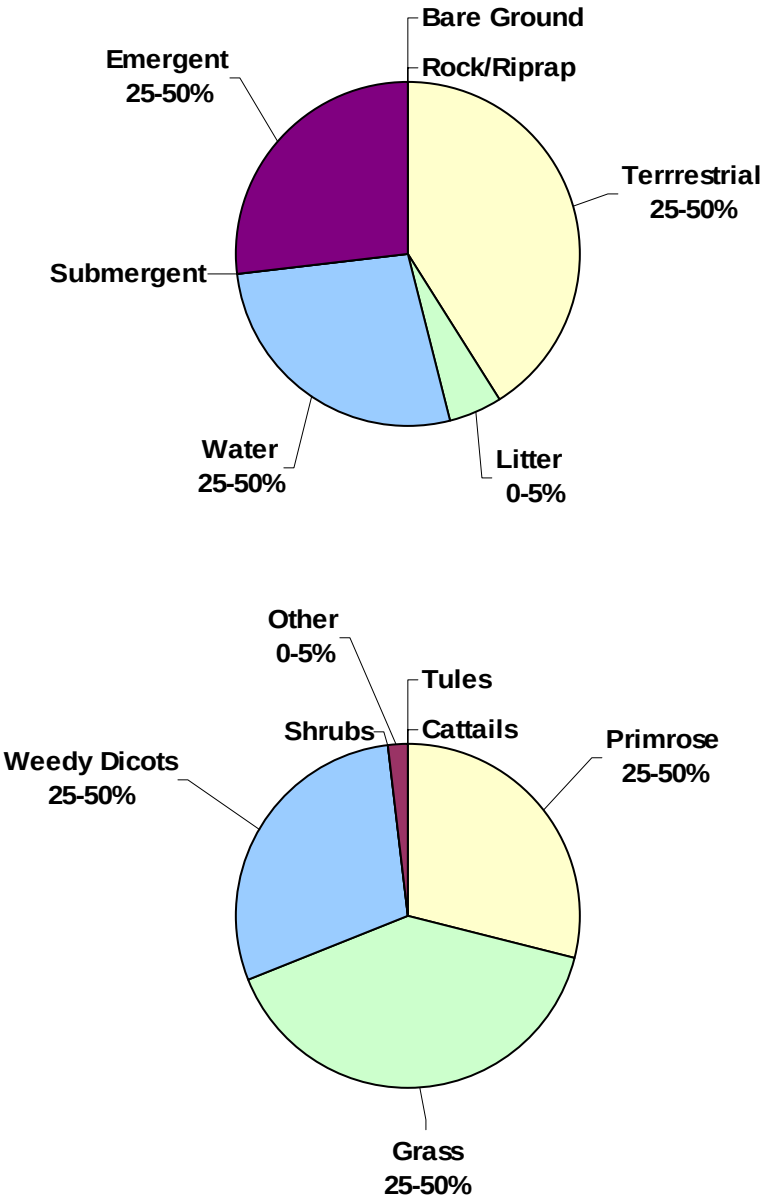



Figure 17. Substrate and vegetative characteristics of the trap line in Betts-Kismat-Silva in the marsh near water control structure K.

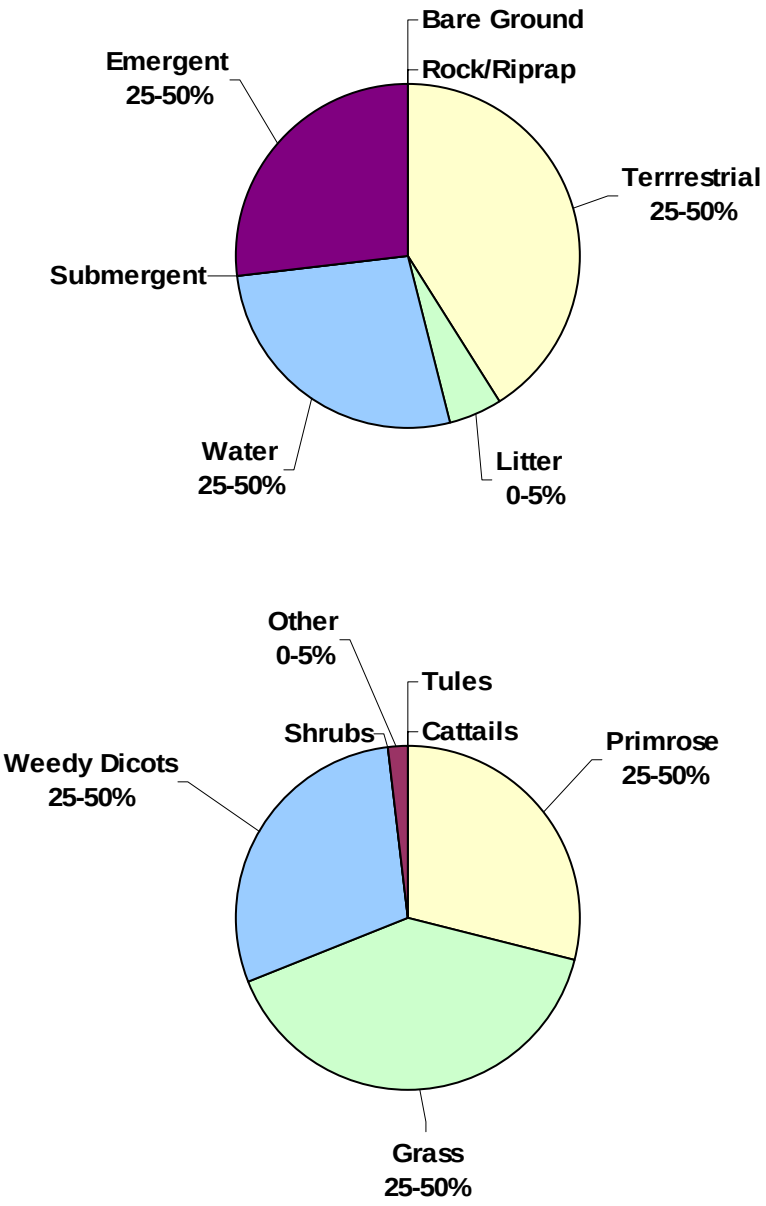
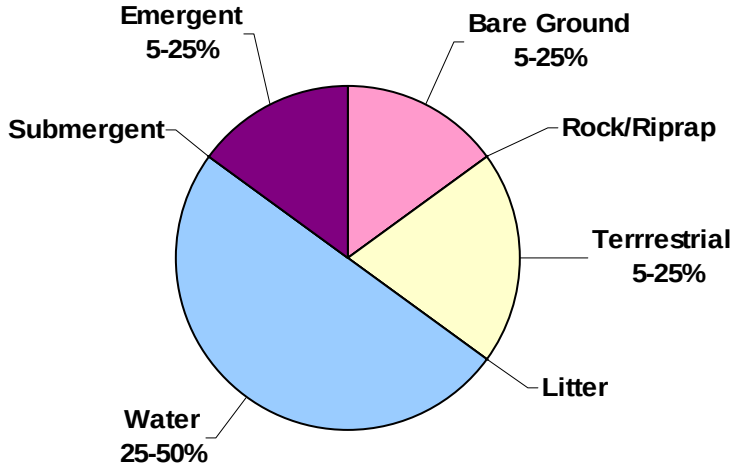



Figure 18. Substrate and vegetative characteristics of the trap line in Betts-Kismat-Silva in a ditch south of water control structure K.



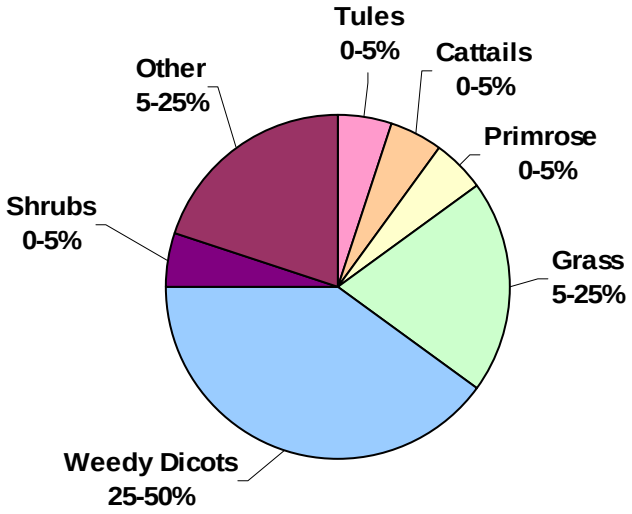




Figure 19. Substrate and vegetative characteristics of the trap line in a ditch on the south border of Ayala.

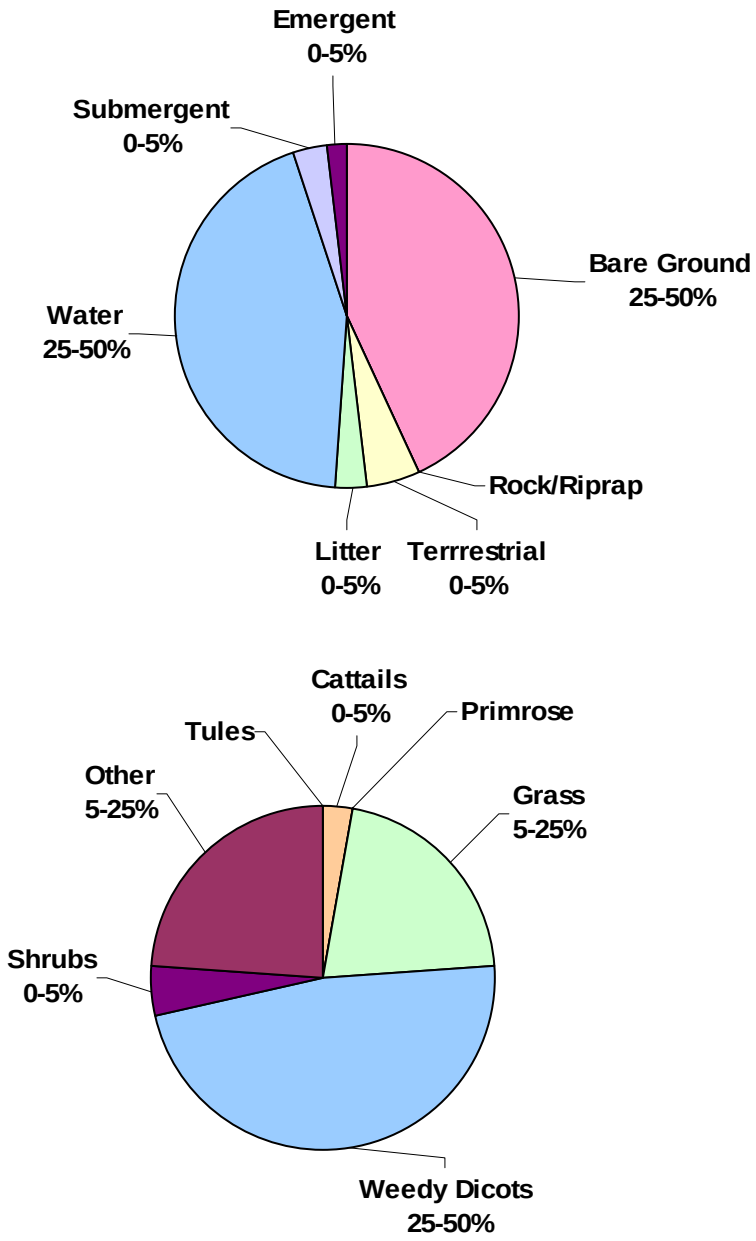



Figure 20. Substrate and vegetative characteristics of the trap line in a ditch on the east border of Ayala.

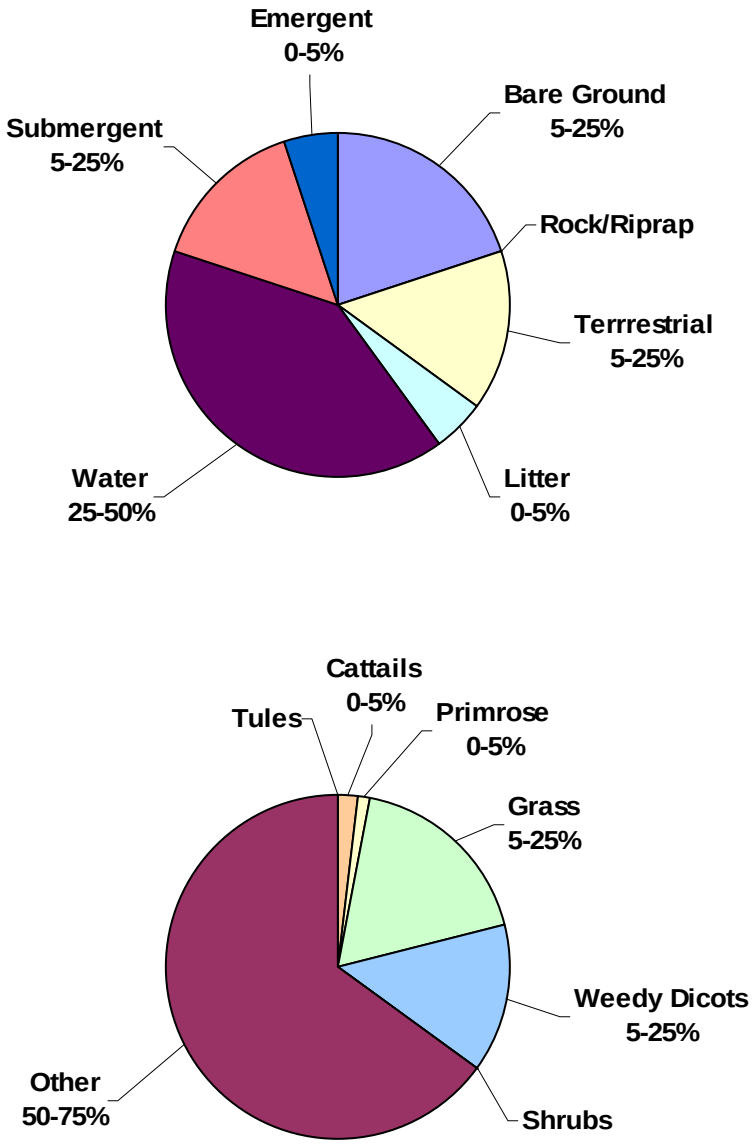
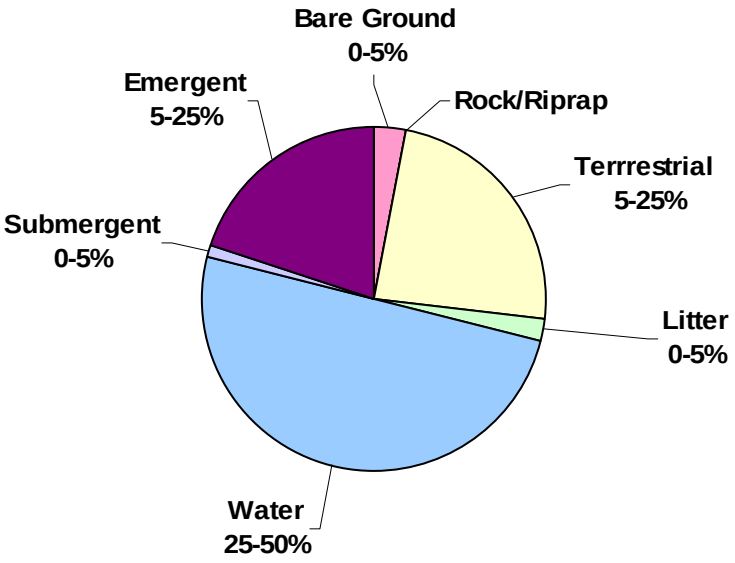



Figure 21. Substrate and vegetative characteristics of the trap line in a ditch on the west side of Sills.



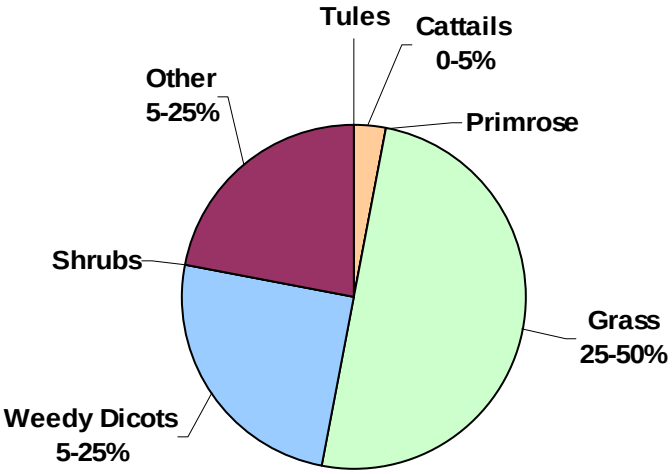




Figure 22. Substrate and vegetative characteristics of the trap line on the north end of Sills.

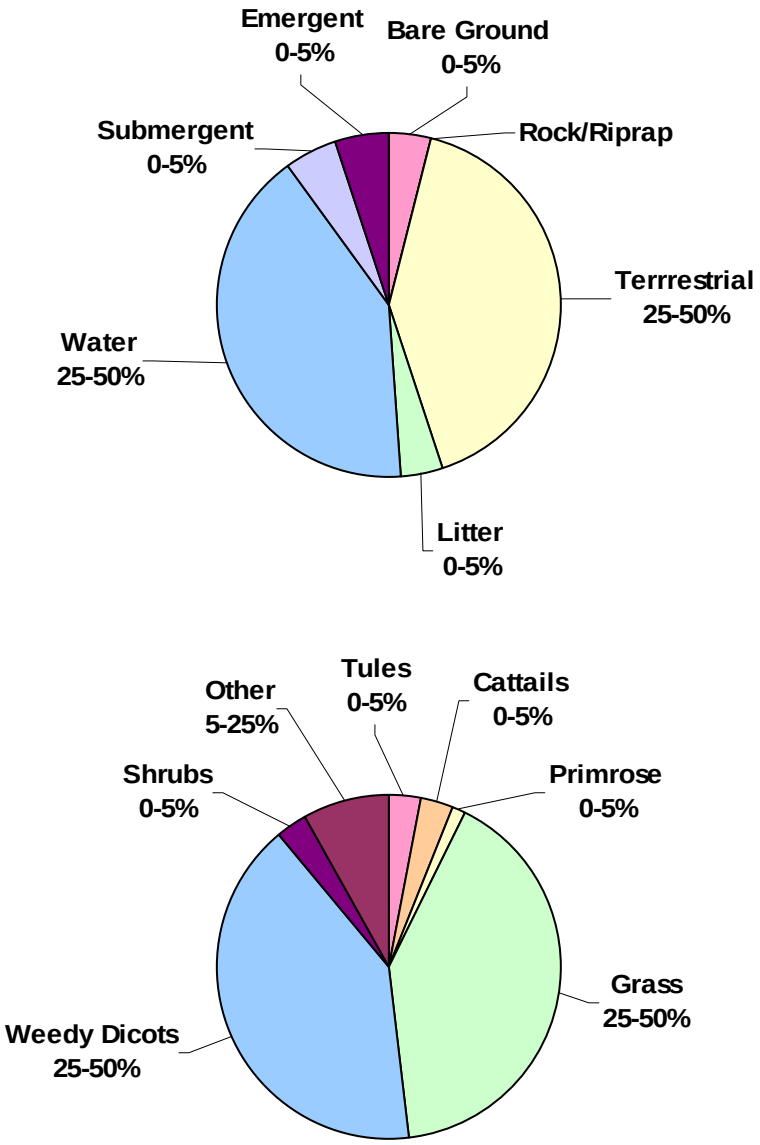
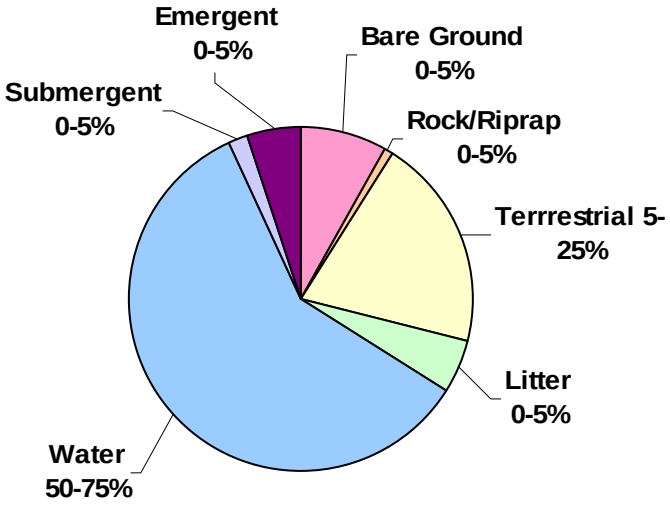



Figure 23. Substrate and vegetative characteristics of the trap line in a ditch on the eastern middle part of Sills.



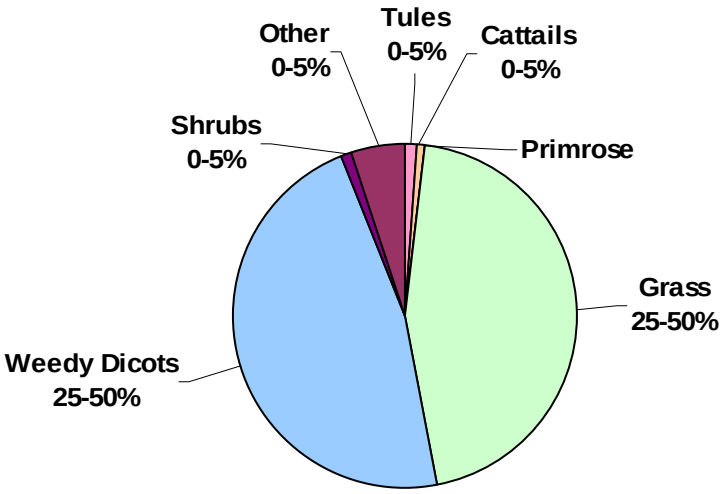




Figure 24. Substrate and vegetative characteristics of the trap line in Snake Alley.

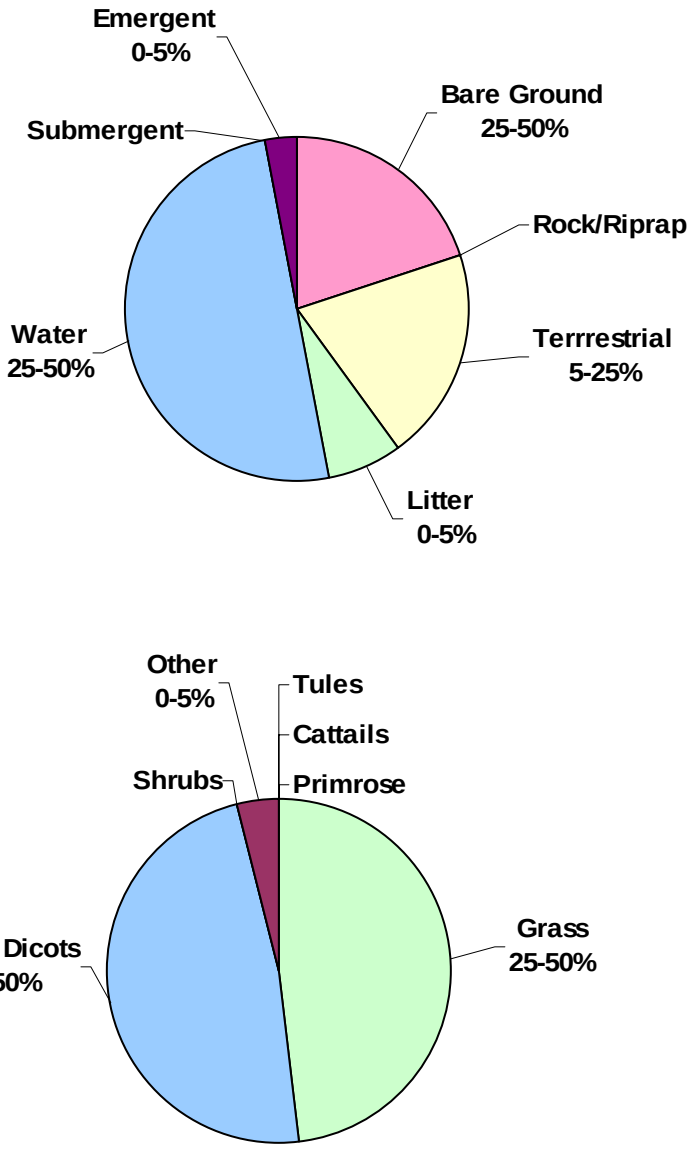



Figure 25. Substrate and vegetative characteristics of the trap line in Airstrip.

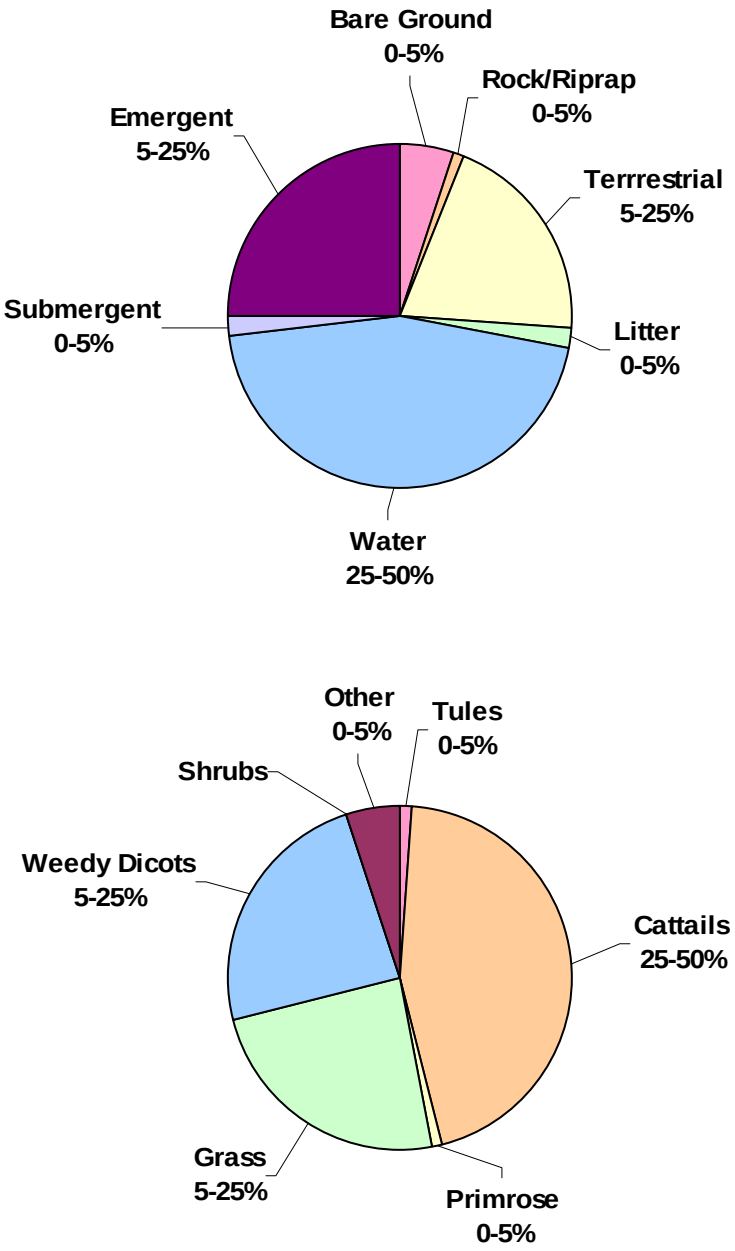



Figure 26. Substrate and vegetative characteristics of the trap line near Elkhorn.

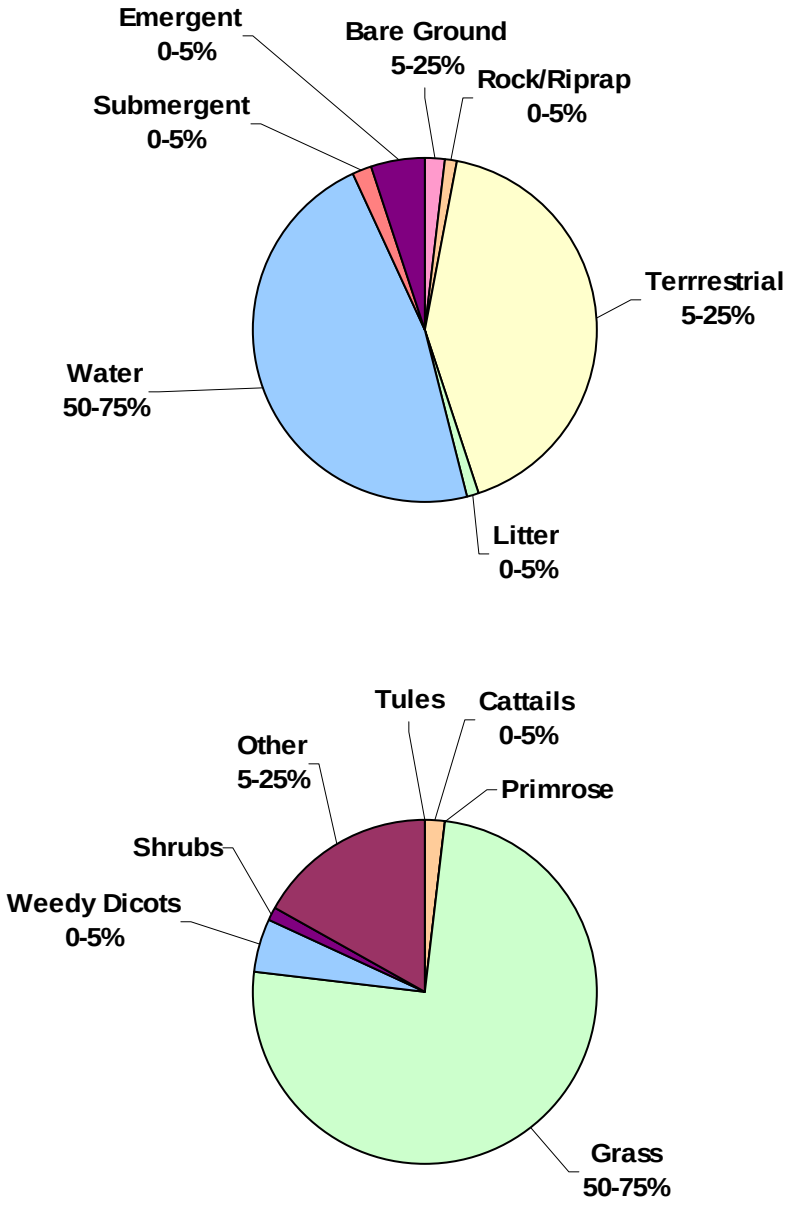
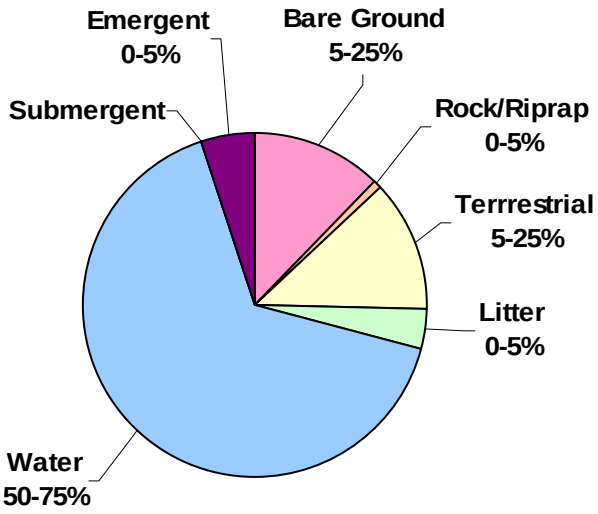



Figure 27. Substrate and vegetative characteristics of the trap line in the northern part of the Lone Tree Road ditch.



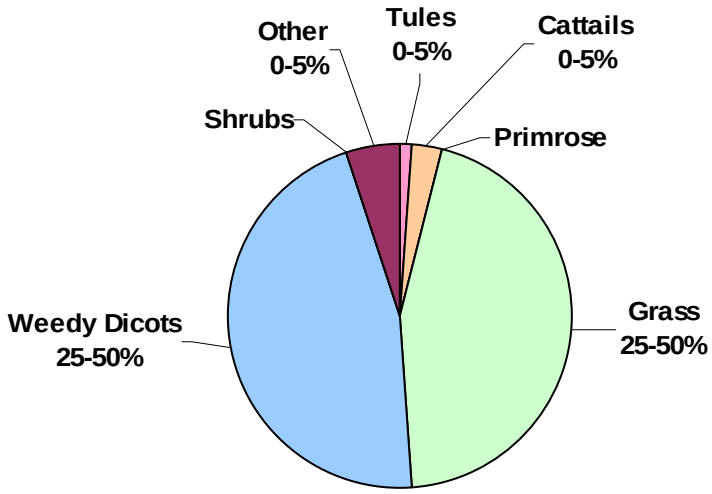




Figure 28. Substrate and vegetative characteristics of the trap line in the central part of the Lone Tree Road ditch.

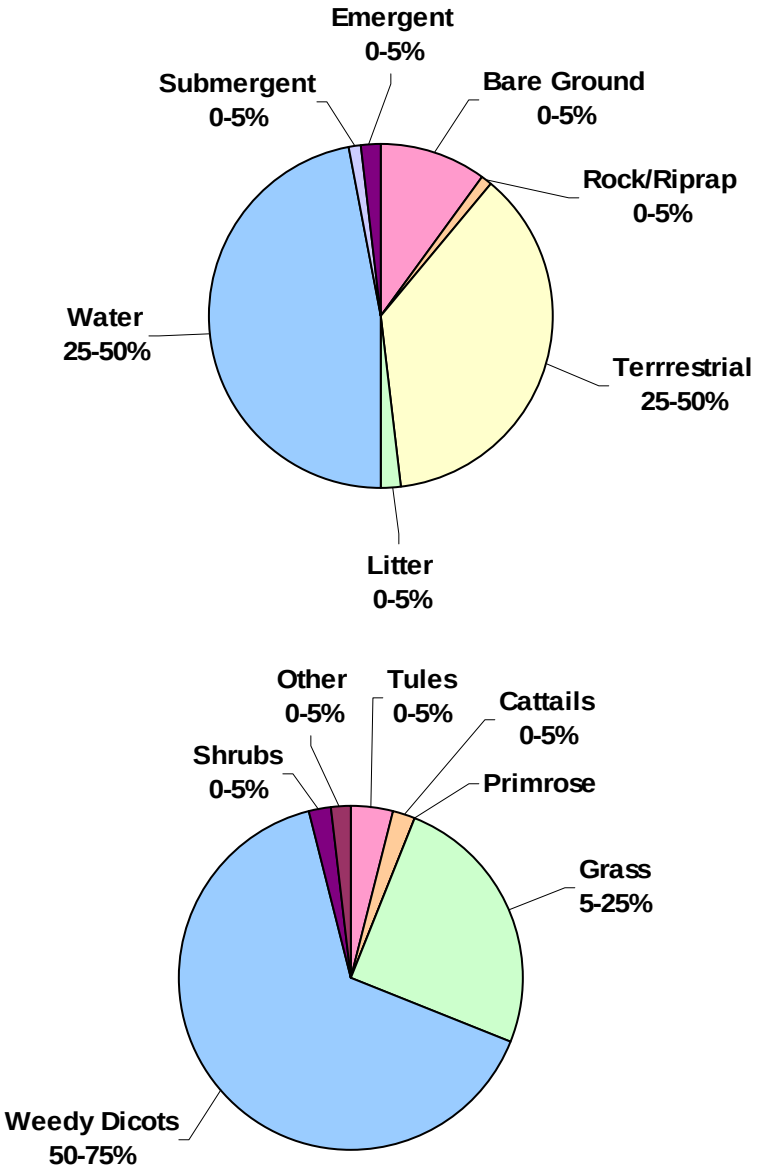



Figure 29. Substrate and vegetative characteristics of the trap line in the south part of the Lone Tree Road ditch

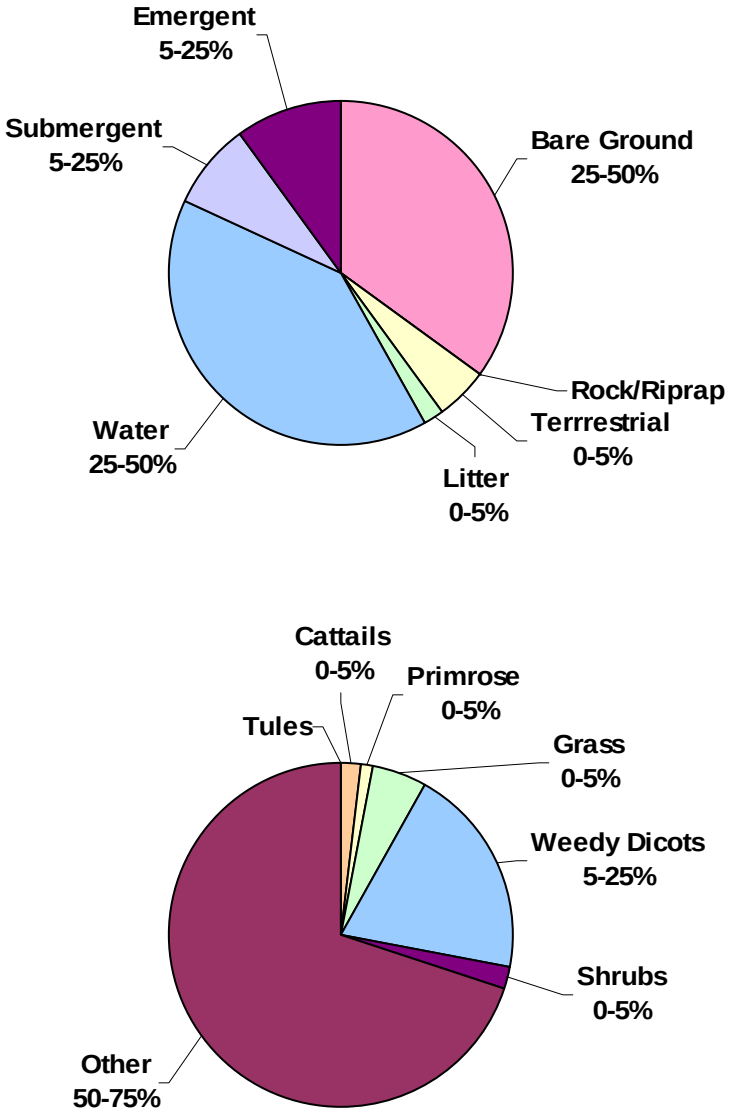



Figure 30. Substrate and vegetative characteristics of the trap line in the Central Main Canal mid section northwest of Lone Tree Road.

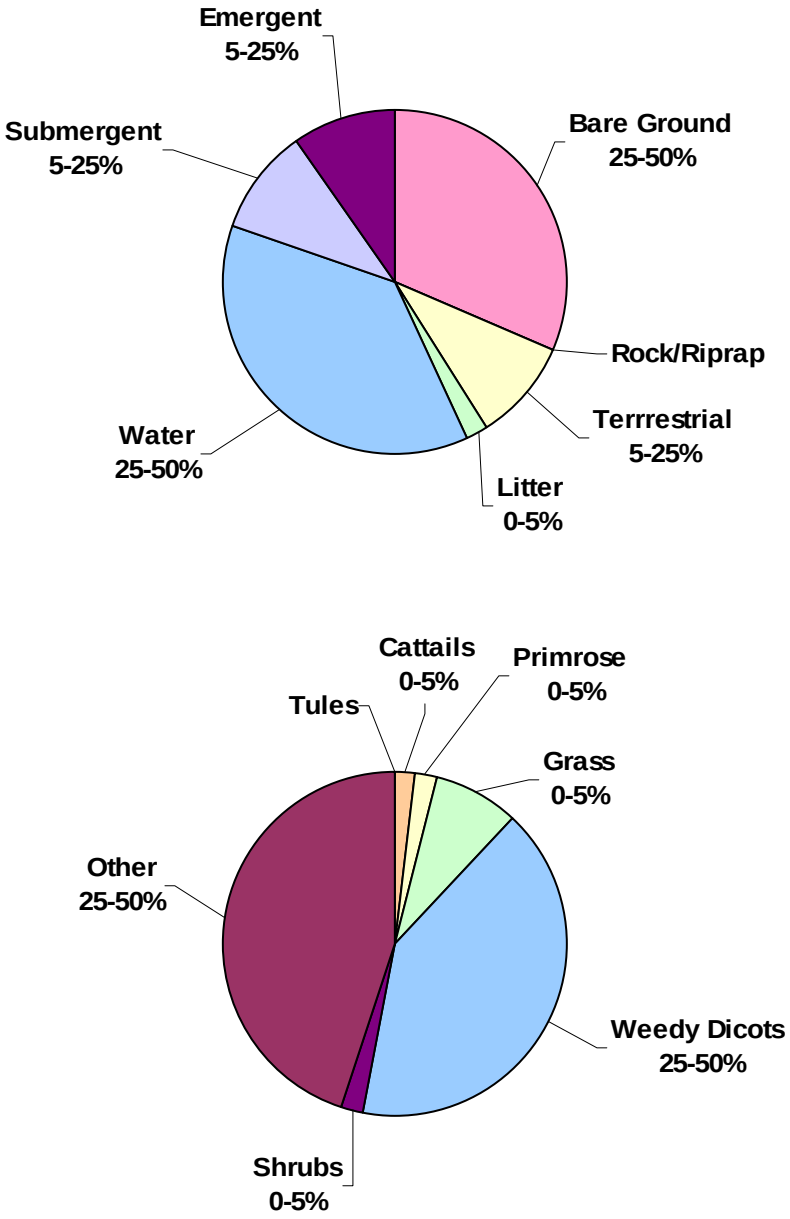



Figure 31. Substrate and vegetative characteristics of the trap line in the Central Main Canal mid section southeast of Lone Tree Road.

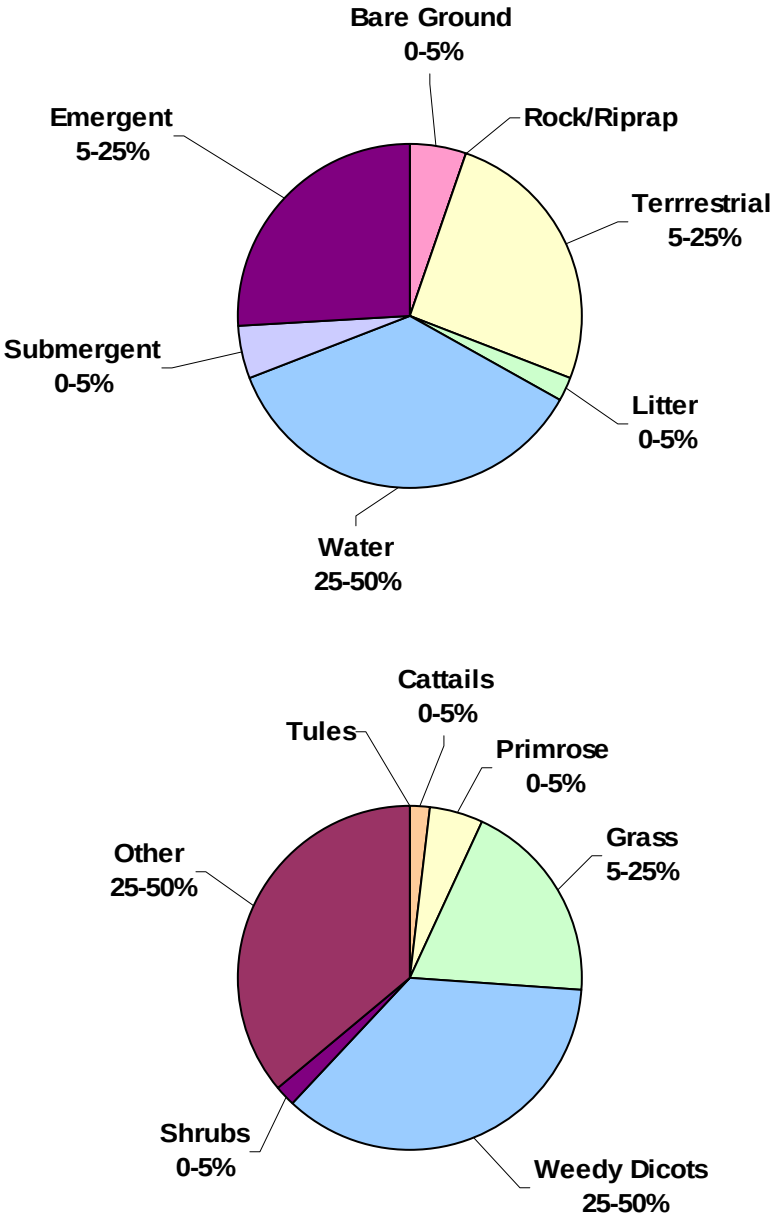



Figure 32. Substrate and vegetative characteristics of the trap line in the Central Main Canal south section.

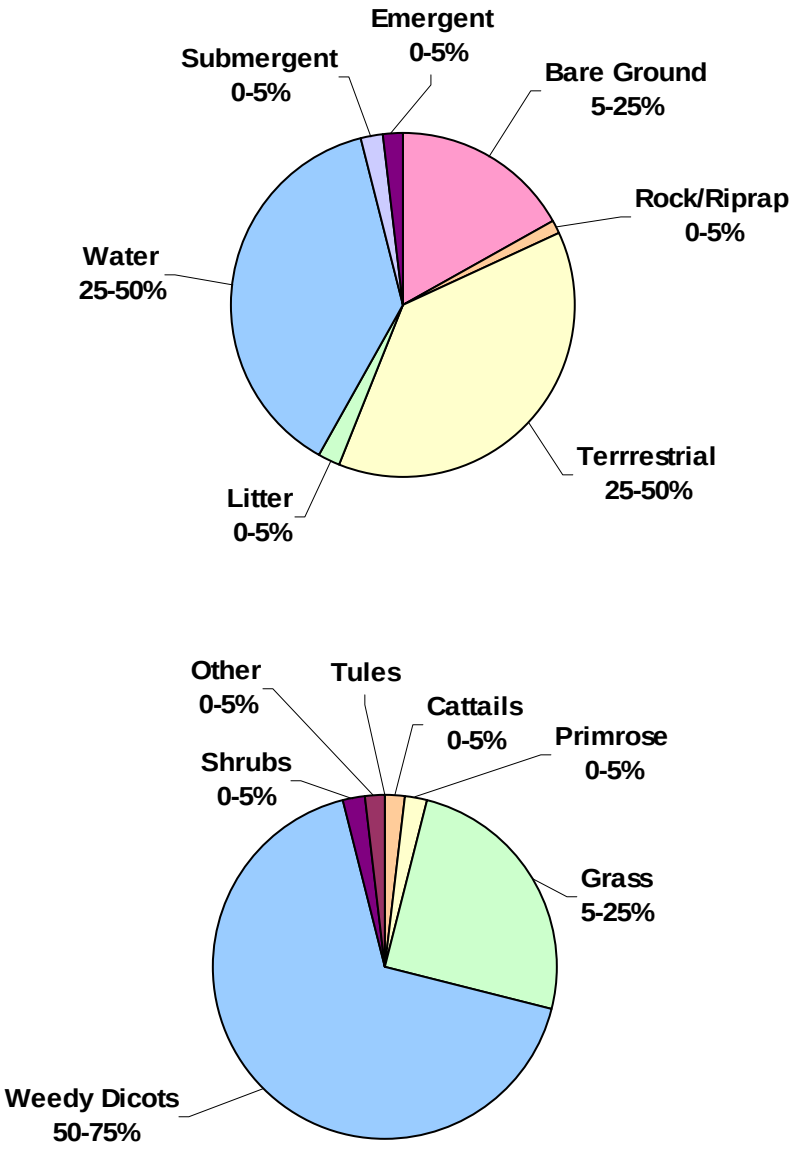



Figure 33. Substrate and vegetative characteristics of the trap line in the Central Main Canal north section.

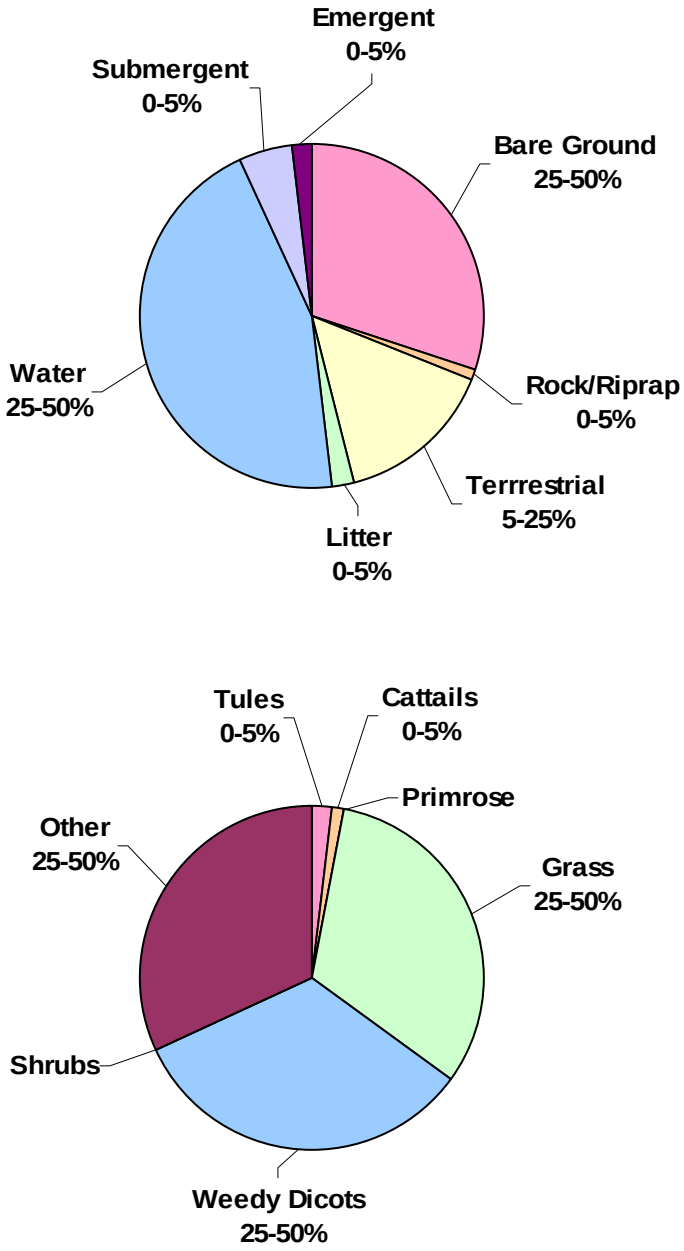
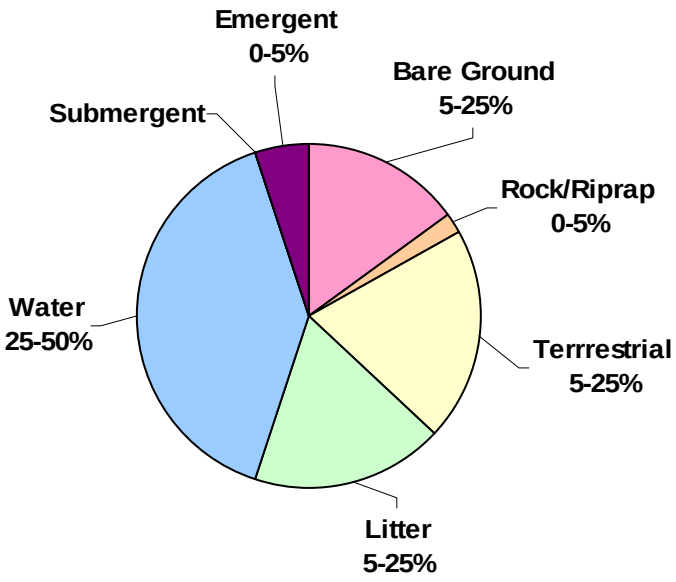



Figure 34. Substrate and vegetative characteristics of the trap line in a ditch along Meister Road.



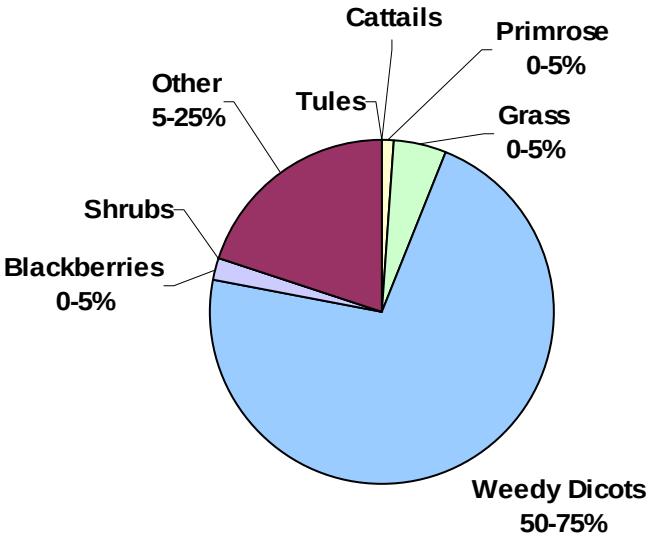




Figure 35. Substrate and vegetative characteristics of the trap line in a ditch along Powerline Road continuous with the Meister Road ditch.