Duncan Dam Project Water Use Plan

Duncan Reservoir Riparian Vegetation Monitoring

Reference: DDMMON#8-2

Year 3 Report

Study Period: April 2015 – January 2016

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DDMMON#8-2 Duncan Reservoir Riparian Vegetation Monitoring Study Year 3 Annual Report (2015)

Final Report

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Cover photo

Site 7 Transect 3 looking up line towards POC at the 26 m mark. All photos © Mary Louise Polzin, VAST Resource Solutions.

Executive Summary

A ten year vegetation monitoring study of the drawdown zone of Duncan Reservoir was initiated in 2009 as part of the implementation of the Duncan Dam Project Water Use Plan (DDM WUP). The new Water Use Operating Plan Alternative S73 (Alt S73) changed the reservoir fill to reach full pool between August 1 and 10. After this the reservoir level will decrease to 575.5 m where it will be maintained within 0.3 m of this level until September 5. This study is intended to evaluate the impacts of operating Alt S73 on vegetation in the drawdown zone. The study provides site-specific data to guide reservoir management and improve the understanding of the relationships between reservoir management, physical environmental conditions, and riparian vegetation. The information will assist in determining areas that could be enhanced and will also contribute to the assessment of prospective wildlife habitat consequences from Alternative S73.

To address the management question of whether changes will occur within the riparian habitat communities and the associated hypotheses (table following), vegetation community dynamics are analyzed every three years by assessing ortho-rectified colour aerial photographs and by inventorying vegetation in quadrats along linear transects that are revisited.

Change-detection mapping showed a reduction in vegetation from 2009 to 2015. Two new communities resulted from secondary and tertiary species moving to the primary positions. One community lost in 2012 and continued to be absent was ‘H12’ with the dominant species *Populus trichocarpa* at the herbaceous type (< 0.5 m in height). This suggests that no new seedling recruitment had occurred since 2012. Vegetated area decreased significantly while barren ground increased in 2015, compared to 2009 and 2012. Barren ground area increased from 15.3 per cent of the total reservoir sampling area in 2009 to 56.4 per cent of the area in 2015. Conversely, vegetated area decreased from 84.7 per cent of reservoir area in 2009 to 43.6 per cent of the area in 2015.

Transect line monitoring revealed that the vegetated area increased upwards and away from the reservoir, as the duration of inundation decreased. Reservoir drawdown zone elevation is directly correlated with inundation time and was associated with the variation in vegetated covered for the reservoir zone, similar to our findings in 2012. Some interannual changes could also reflect seasonal weather variation that occurred between sampling years. Future monitoring could further investigate the influence of weather variation on vegetation cover and composition.

Species richness was the same as in 2009 and slightly higher than in 2012. Diversity was slightly higher in 2015 compared to 2012 but both years showed very large decreases from 2009. Species diversity continued to be high near full-pool and decreased as elevation decreased and inundation durations increased.

Changes occurred in plant distribution patterns and in the predominant plant species in 2015 as compared to 2009. The second-ranked species in 2009, *Carex utriculata* (beaked sedge), moved to fourth position in 2015. This wetland graminoid may be a useful indicator species to assess the effect of the Alternative S73 regime on previously established vegetation communities.

We assessed woody debris as part of the bare ground class and found that within the first metre of elevation below from full-pool it may be impacting woody plant species recruitment and survival. This factor should be included in the 2018 assessment to further investigate its influence on vegetation colonization and succession.

These data and analyses will be instructive for developing dam operation patterns that could benefit reservoir environments and riparian vegetation community success, as well as assisting key plant species for reservoir enhancement projects. This ongoing study will provide information

on physical factors such as elevation, inundation tolerances, substrate, and slope preferences, for the favoured species as well as for disfavoured plants such as invasive weeds.

KEYWORDS Duncan Reservoir, Drawdown Zone, Inundation Tolerance, Riparian Vegetation

Objectives	Management Question	Management Hypotheses	Study Year 3 (2015) Status
1) To assess riparian vegetation productivity, including area of riparian vegetation habitat in the reservoir drawdown zone.	1) Will the implementation of DDM WUP result in neutral, positive, or negative changes to riparian vegetation communities within the drawdown zone for the Duncan Reservoir?	H_{01}: Alternative S73 will not result in decreases in area, and alterations in the species composition, of wetland and riparian vegetation communities.	Summary of 2015 results showed a significant decrease in vegetation cover by area and an increase in bare ground area. Weather may be an important factor but there were no two sampling years with similar spring weather. Future sampling may indicate the level of spring weather effects on vegetation communities, and especially annual plant communities. Hypotheses testing results will define how much each factor tested contributes to the change in vegetation cover. It will also answer the management question which at this point we cannot say that the implementation of DDM WUP is the cause of the changes noted in vegetation.
2) To assess the inundation tolerance through riparian productivity potential in the reservoir drawdown zone during the growing season.		H_{02}: Reservoir elevations will not affect riparian distribution and abundance through the duration and frequency of root-zone flooding.	Based on 2015 assessment, inundation tolerance was limited to first metre drop in elevation from full-pool. Extreme dry spring weather may have contributed to the reduced cover for the drawdown zone. Woody debris and 2012 reservoir levels above full-pool were possible factors in reduction of vegetation cover including woody species from the 85th percentile exposed zone. Diversity has been significantly decreasing since 2009.

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1.0 INTRODUCTION

1.1 Project Overview

This report summarizes the third triannual field season (Study Year 3, 2015) of the riparian vegetation monitoring study (DDMMON#8-2) for the Duncan Reservoir drawdown zone (year 7 since the study began in 2009). The original Duncan Lake was 25 km long with the discharge from the lake (Duncan River) starting approximately 4 km upstream from the current dam location. The original location of the Houser community was at the downstream end of Duncan Lake which had to be moved to higher ground because of the erection of Duncan Dam and the subsequent flooding and enlargement of Duncan Lake creating the Duncan reservoir. The Duncan Reservoir is located north of the Duncan Dam, 11 km upstream from Kootenay Lake, in the central Columbia Mountains of southeastern British Columbia (Figure 1-1). It is 45 km long, averages 1.5 km in width, and is fed by a rugged, high-elevation drainage area of 2,010 km^2 (Miles 2002).

Operational changes were recommended in 2005 by BC Hydro's Duncan Dam Water Use Plan Consultative Committee Report (DDWUP CC). This was part of a larger process for the lower Duncan River and Duncan reservoir that seeks to address previously under-recognized environmental and social issues (BC Hydro 2005). The recommended new operating Alternative S73 (Alt S73) regime (fill and drawdown level control) has been implemented since January 2008. Alt S73 regime has the reservoir reaching full pool (576.7 m) between August 1 and August 10, then levels decrease to 575.5 m and maintained within 0.3 m of this level until September 5th (BC Hydro 2007).

Alt S73 was expected to have a negative effect on the wildlife habitat along the Duncan Reservoir as a result of decreasing vegetation distribution and abundance (BC Hydro 2005). Consequently a long-term wetland and riparian vegetation monitoring program was recommended by the DDM WUP CC to assess Alt S73. This would involve analyses of riparian vegetation distribution and abundance, and testing of hypotheses underlying the approach taken in the WUP.

This study is designed to sample and analyze the conditions of existing vegetation communities triennially for 10 years and to track any changes that may occur in vegetation distribution and abundance under the implementation of Alt S73. The second vegetation survey was deferred from Year 3 (2011) to Year 4 (2012) (Study Year 2) of the 10 year project.

The Duncan Dam is one of the facilities that provide flood control under the term of the Columbia River Treaty. As such, the dam was operated to minimize flooding impacts downstream. In terms of reservoir operation, Alt S73 differs from the 1968-2007 operating regime in the following ways:

Pre-2008: The average reservoir level from 1968 to 2007 reached a fill level of 575.7 m by July 29 and stayed at this level to August 30 (full-pool is 576.7 m). From September 1 to early December there was gradual draining to 569.8 m. The levels dropped rapidly from December through March 20 to 550.5 m. Levels were stable at 550 m (approximately) for the remaining time in March until April 30, when levels rose quickly to 575.7 m (one metre below full-pool). However, there was substantial annual variation during the Pre-Alt S73 years (Figure 1-2).

Figure 1-1: The location of Duncan Reservoir and the 2015 sampling sites. Site 14 is only used in air photo analysis

Alt S73: Since 2008, the annual variation has substantially decreased (average variation = 1.4 m) compared to Pre-Alt S73 (average variation = 17.4 m). Drawdown reaches the lowest level of approximately 547 m April to first week in May with reduced variation compared to Pre-Alt S73 (average Pre-Alt = 9.2 m, average Alt = 0.3 m) with 2010 levels showing the largest variation compared to the average levels (Figure 1-2).

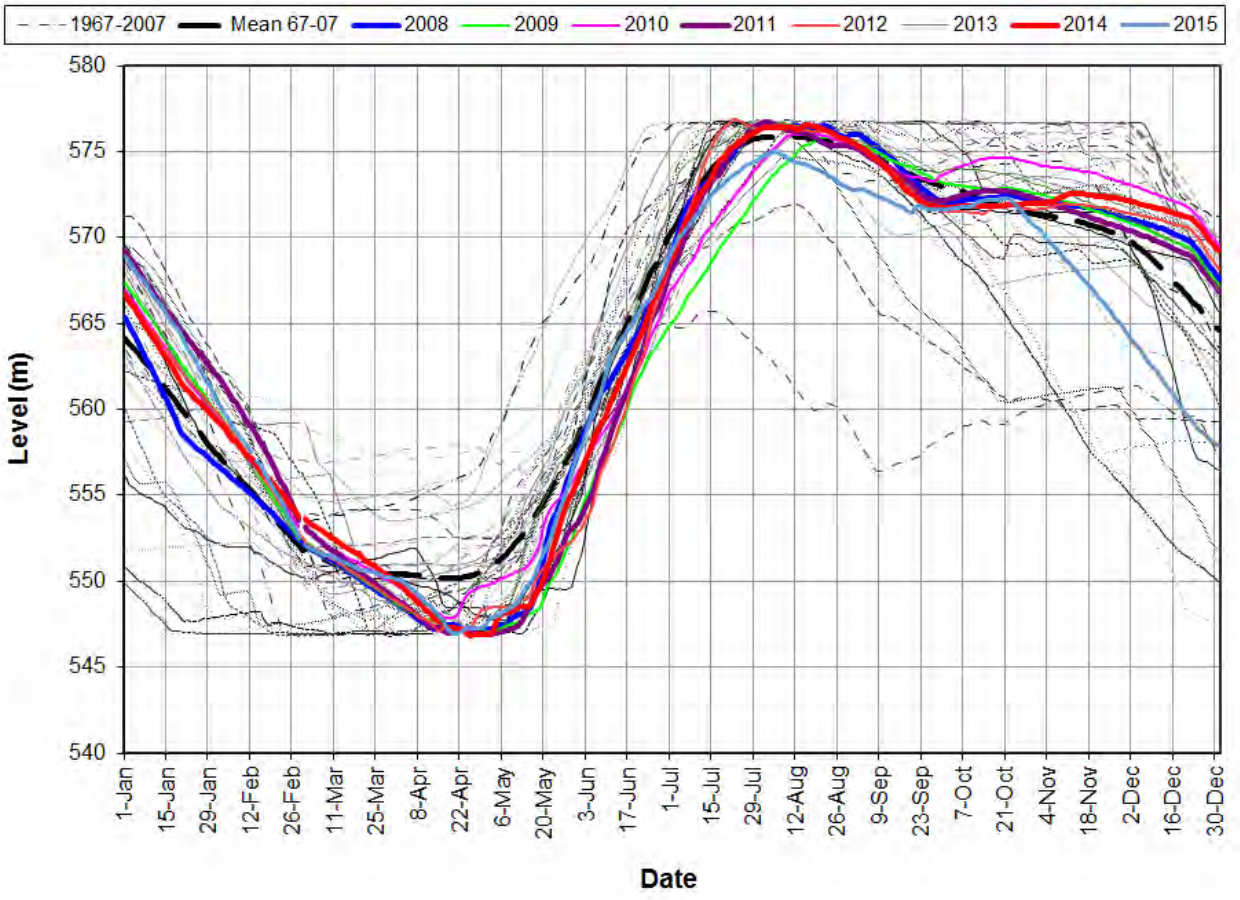


Figure 1-2: Mean Daily Water Levels (m) for Duncan Reservoir at Duncan Dam (WSC Station 08NH127) 1967 – 2015. Bold lines are years of analyses

1.2 Background

Data from storage reservoirs world-wide indicate that *reservoir drawdown zones impose physically stressful environments for vegetation* (Nilsson and Keddy 1988 and Hill et al. 1998). Drawdown or storage reservoirs are very common worldwide and are managed to trap flows during certain intervals with subsequent controlled release of the stored water. These reservoirs provide deliberate strategies to reduce downstream flooding; enable hydroelectric power generation; provide off-stream water for agricultural, urban and industrial uses; and enable environmental in-stream flows for aquatic or riparian ecosystems and various other applications.

Accompanying the deliberate manipulation of seasonal river flows and water supplies, there is periodic filling and drawdown of the storage reservoir pools. When full, reservoir banks are completely inundated, while during drawdown, those same zones become fully exposed. Aquatic plants are able to withstand inundation, but are unable to survive in dry

conditions. Conversely, terrestrial plants are generally intolerant of complete inundation, particularly when such inundation lasts for days, weeks, or months.

Wetland and riparian plants are better able to withstand cycles of inundation, but these same plants are generally drought-intolerant. Thus, there is a general trade-off relative to the capacity of plants to survive in very wet *versus* very dry environments. Consequently, few if any plants are able to survive in reservoir drawdown zones, and these areas are typically almost barren of vegetation (Nilsson et al. 1997, Jansson et al. 2000). The exceptions generally involve ruderal annuals, which are species that rapidly colonize disturbed areas, since they are able to complete their life cycle within the limited drawdown interval (Braatne et al. 2003). Seedlings or occasionally clonal propagules of these plants are able to establish in the newly-exposed moist reservoir shorelines and the successful plants are able to quickly grow and reproduce, producing seeds prior to the subsequent inundation. The ruderal annuals are commonly weedy plants that are able to establish quickly and often have prolific reproductive potential. Such plants are often alien species that have typically been unintentionally introduced into a region and their prolific reproductive capacities may allow them to colonize areas characterized by disturbance or abrupt physical change, as is present in reservoir drawdown zones.

Despite the global abundance of drawdown reservoirs, there have been far fewer scientific studies of associated vegetation than has been the case for many other environments, such as wetland and riparian zones (Hill et al. 1998). Many of the same physical factors likely underlie vegetation establishment, survival and expansion in reservoirs, wetland and riparian zones (Jansson et al. 2000), and the distinctive and severe reservoir environments may even provide opportunities for scientific study (Nilsson and Keddy 1988, Braatne et al. 2008). Since these zones are relatively impoverished, there are fewer species to investigate and fewer interspecific interactions (e.g., competition). Since the zones are dominated by ruderal annuals, the process of colonization is critical and may yield useful information about the life history components of the associated plants, as well as insight into the fundamental nature of weedy and invasive plants.

Distribution patterns predicted prior to baseline data analyses were found to be generally accurate (Polzin et al. 2010) and some factors became better understood as the project progressed and more data were collected. One pattern not predicted was that first year seedling growth of some perennial species occurred within the mid-level elevation zones of the drawdown zone where annuals mainly occur. Cover densities were generally less than one per cent but the soil seed bank still had some viable seeds in these elevational zones. In addition to the influences due to reservoir regulation, biological processes that influence seedling establishment and survival are affected by fluctuations in temperature, precipitation, and storm events that persist in the natural setting.

1.3 Project Description and Objectives

The key management question in relation to wildlife interests of the DDM WUP was:

- *Will the implementation of the DDM WUP result in neutral, positive or negative changes in wildlife resources for the Duncan Reservoir?*

However, the actual testing of the management question specific to wildlife resources was dropped from the RFP with vegetation data to be supplied to the wildlife project for the reservoir. This study will look at the implementation of the DDM WUP to see if it results in neutral, positive or negative changes in vegetation for the Duncan Reservoir. The corrected key management question is:

- *Will the implementation of DDM WUP result in neutral, positive, or negative changes to riparian vegetation communities within the drawdown zone for the Duncan Reservoir?*

The DDM WUP CC identified two performance measures for testing the effects of Alt 73 on existing vegetation communities in the Duncan Reservoir (BC Hydro 2005). These are:

- **Riparian habitat productivity** - *long term median occurrence*: hectares of herbaceous riparian habitat in the reservoir drawdown zone to an elevation of approximately 8 m below full-pool during growing season (1 April to 31 October); and
- **Riparian vegetation** - *inundation tolerance*: hectares of *potential* herbaceous and shrub areas in the reservoir drawdown zone in the growing season (1 April to 31 October).

There is an expectation that Alt S73 will decrease the area of riparian vegetation around the reservoir drawdown zone compared to the prior operating regime (BC Hydro 2009), because the reservoir level will be held higher throughout late summer and early fall. However, the zone around the upper elevations may be exposed longer in the spring/early summer due to a slower fill rate, thereby potentially providing a slightly longer pre-inundation growing season. Reduction of the wide variation experienced Pre-Alt S73 may also contribute to a more robust riparian plant community within the first metre drop in elevation from full-pool (576.7 m to 575.7 m).

The two hypotheses to be tested as part of this monitoring program in Year 10 (2018) are:

"**H_{01}**: Alt S73 will not result in a decrease to the area and alterations in the species composition of both wetland and riparian vegetation communities"; and

"**H_{02}**: Reservoir elevations do not affect riparian distribution and abundance through the duration and frequency of root-zone flooding".

H_{02} is designed to investigate species-elevation relationships, and results should facilitate predictions regarding plant community response to a given operating regime.

The objectives of the monitoring program are to collect and analyze field data on riparian vegetation around the reservoir at sites predetermined by BC Hydro (2009) to test the null hypotheses**,** and to compare performance measures over time in 2018. It is also to address the corrected management question *Will the implementation of the DDM WUP result in neutral, positive or negative changes in riparian vegetation for the Duncan Reservoir*.

The specific program objectives are (BC Hydro 2009):

- To map the distribution of wetland and riparian vegetation within the drawdown zone of Duncan Reservoir using aerial photography, starting in Study Year 1 of the monitoring program;
- To make special note of any traditional use plant species that occur within the drawdown zone of Duncan Reservoir;
- To monitor changes over time in the area coverage and plant species composition of vegetated communities within the drawdown zone of Duncan Reservoir under operating regime alternative S73; and

- To provide the basis for assessing potential wildlife community changes resulting from the WUP constraints.

The objectives for the Study Year 3 (this report), were to collect air photo data for mapping the vegetation distribution in the reservoir, field data collection of on-site habitat, and photo monitoring to complete a summary analyses for the current year resulting in a summary report for the year studied. Data collected in this report will be added to the information gathered in past years to be used for hypotheses testing in 2018.

2.0 METHODS

2.1 Aerial Photography

Aerial photography was completed by Kisik Aerial Surveys subcontracted by BC Hydro. The work corresponds to the filling of the reservoir so levels to photograph would capture the sites below 566.7 m level. There were thirteen sites located around the reservoir that were identified in 2009 (BC Hydro 2009). The June 6, 2015 flight enabled 10 cm (resolution pixel size) aerial photo acquisition, and subsequent ortho-rectification, colour balancing, image sharpening and mosaic production. At the time of aerial photo acquisition, the reservoir level was at 560.2 m, which was below the maximum target level of 566.7 m. This was approximately two and half weeks earlier than in 2012 because of the predicted fill levels were increasing faster than in 2012 and a weather disturbance pattern was predicted for the following week. The exceptionally warm early spring condition also contributed to the decision to fly earlier. A visit to Site 1 on May 4, 2015 supported the earlier flight because plant growth was more advanced than at the same date in previous years.

The air photos were analysed using a Planar Stereo/3D Monitor for stereoscopic viewing on a computer monitor. Delineation of plant communities utilizing the ortho-rectified aerial photographs provided measurement of the area colonized by different plant communities and the areas of bare ground. A comparison between years addresses the first null hypothesis of whether changes in vegetation cover and plant community composition occurred within the drawdown zone and data will be added to complete the data set for analyses in 2018. This will enable documentation and measurements of changes in area and distribution of plant communities over the ten-year period after the implementation of Alt S73.

2.2 GIS Method

The use of GIS with the ortho-rectified aerial photographs allowed analyses of vegetation community types, vegetation community area calculations, and inundation times that occur at the sampling sites. GIS analyses generate the data needed to address H_{01} and contribute information for H_{02} analyses. There were nine “high riparian potential” sites identified by BC Hydro (2009). For these nine sites (Sites 1, 2, 3, 4, 5, 6, 7, 10, and 13), a weekly average reservoir elevation analysis was completed to determine the area of each site exposed during the growing season (April 1 to September 30). Determination of the area of the drawdown zone that was exposed for 85 to 100 per cent of the growing season was also completed for each of the nine sites (Appendix 2). The information will contribute to the data used to assess performance measure of “Riparian Productivity – *inundation tolerance*” and the H_{01} (BC Hydro 2009) in 2018.

The contour, mass point, and break-line data for the study area were provided by BC Hydro in MicroStation V8 DGN format with the following limitation:

"Please be advised that the 1 Metre contours that have been sent for Duncan and Kootenay Lake are not edited, and far exceed the vertical accuracy in some areas. The data was a combination of source material including LiDAR, photogrammetry and TRIM. The area covered is only from water line at time of photography up to 580 M. Coordinates are in NAD83 Z1" (L. Giles, pers. comm., 2009).

Thus, analyses derived using source elevations are only as accurate as the source data. All acquired elevation data were converted to ArcGIS shapefile format and imported into an ArcGIS geodatabase. Utilizing the 3D Analyst extension, elevation data were used to generate a Triangular Irregular Network (TIN) to represent surface morphology. The TIN was used to perform an analysis of the drawdown zone surface area, in which the surface area above the weekly average reservoir elevation was calculated for each week during the growing season, for each of the 12 sites. Also calculated during this analysis were the surface areas of the drawdown zone exposed for 85 to 100 per cent of the growing season (April 1 - September 30) at each of the 12 sites. The TIN created for each site was used for 2014 elevation based analyses. GIS data submission is digital and was submitted separately from this document, and is referenced in Appendix 7.

2.3 Sampling Design

The overall sampling design for site selection, size of sites, and four sampling periods was pre-set by BC Hydro (2009). The field sampling design from 2009 (Polzin et al. 2010) with the minor modifications in 2012 builds upon a literature-based hydrogeomorphic framework, in which riparian plants have particular water and substrate requirements for successful colonization (Auble et al. 1994, Mahoney and Rood 1998, and Polzin and Rood 2006).

The 12 sites monitored in 2009 had monitoring repeated in 2012 and again in 2015, with this third inventory providing the basis for this report. Site 14 was added to the aerial photography assessment in 2009 and was not part of the field site monitoring component (Polzin et al. 2010).

Transverse or cross-sectional belt transects, stratified random sampling design, and sampling methods are described in detail in Polzin et al. (2010) and slight changes that occurred in 2012 are described in Polzin and Rood (2013). Transect lines had tag numbers attached to a tree or stamped into the flat top plate on a rebar for the point-of-commencement (POC) and the bearing for the line recorded. The established POCs and end-of-transect (EOTs) had their locations recorded utilizing a Trimble precision GPS. The 2015 sampling design and methods thus followed the 2009 and 2012 protocols.

2.4 Field Sampling of Vegetation Communities

The field monitoring of the reservoir drawdown zone and upland zone took place between June 8 and June 13, 2015. The 2015 monitoring crew members consisted of a senior riparian specialist, (same person since 2009) an intermediate biologist and a technician. The sampling occurred between the elevations of 576.7 m and 566.7 m for the reservoir drawdown zone and 576.7 m and 578.7 m for the upland zone. Established POCs were located and transect lines running down from full-pool (drawdown zone) and running upland were setup using tape measures and bearings, repeating the same process used in Polzin et al. (2009) and Polzin and Rood (2013).

Tasks completed by the three person field crew included:

- Sampling of vegetation species along the drawdown and upland sampling zone;

- Photographs were taken at the same photo monitoring points set up in 2009; and
- Surface substrate texture (class size) sampling along the complete length of the transect lines by area with start and end points where change occurred recorded at the corresponding metre mark. Substrate texture was divided into the following five class sizes according to the Field Manual for Describing Terrestrial Ecosystems (Luttmerding et al. 1998):
    - o silt (0.002-0.062 mm);
    - o sand (0.062-2.00 mm);
    - o gravel (2-64 mm);
    - o cobble (64-256 mm); and
    - o boulders (>256 mm).

The Daubenmire (1959) per cent cover sampling method was used for quadrat sampling (1 m^2, 8 m^2 and 50 m^2). Per cent cover of each plant species was recorded using per cent cover codes (Table 2-1) with an additional bracket added for trace cover (less than 1 per cent). Codes were recorded in the field and the mid-point was the data entry. The mid-point for the new Code 1 for trace was determined to be 0.1. This was determined by tracking actual estimated percentages of less than 1 resulting in a 0.1 average. Detailed field procedures are located in Polzin et al. (2010) and Polzin and Rood (2013).

Table 2-1: Per cent cover codes, with description of the codes used for vegetation cover data collection.

Vegetation Per Cent Cover Codes		
	Per cent Coverage	
Code	*Range*	*Mid-point*
1	< 1	0.1
2	>1 - 5	2.5
3	>5 - 25	15
4	>25 - 50	37.5
5	>50 - 75	62.5
6	>75 - 95	85
7	>95 - 100	97.5

The three quadrat sampling sizes were referred to as Herb quadrats (1 m^2) sampled all herbaceous species (all heights) as well as any woody species ≤ 0.5 m in height. All shrub and tree species recorded in herb quadrats were marked as such so no analyses occurred with mixed quadrat size for woody species. Shrub quadrats (8 m^2) sampled all woody species between 0.5 m and 2.0 m in height. All tree species recorded within a shrub quadrat were marked for tracking purposes and to ensure no mixing of quadrat size information for tree species. Tree quadrats (50 m^2) sampled all shrub and tree species greater than 2 m in height and all shrub species that they occurred within a tree size quadrat were marked for tracking purposes.

Upland Dominant Species were determined by selecting species with at least 18 per cent cumulative cover and greater than 18 per cent frequency for the upland reservoir transects or at least 18 per cent frequency of occurrence for the reservoir as a single unit (all sites combined) but these species may have had less than 18 per cent cover. They were ranked in order of highest cover and frequency. Most species satisfied both criteria but some occurred with frequencies greater than 18 per cent but less than 18 per cent cumulative cover. Site dominant species selection was slightly different because of the small sample sizes for individual sites. Site dominant species selection included species with at least 18

per cent cumulative cover from more than one quadrat and/or 60 per cent frequency rates. Exceptions applied if the vegetation community only occurred in one quadrat for the site, and then the highest cumulative cover species was selected (example Shrub cover for Site 3) or if all species recorded for the vegetation community only occurred along two transect lines. Dominant species were ranked in order of highest per cent cover and highest frequencies.

Reservoir Dominant Species were determined by selecting species with at least five per cent cumulative cover which was consistent with 2012 selection criteria for the dominant species for the reservoir drawdown zone transects. Because of the increase in the number of quadrats per transect line in the drawdown zone, minimum frequency was not required as a selection parameter (required for upland dominant species because of the limited number of quadrats as measured over two metre change in elevation). The five per cent or greater cumulative cover criteria resulted in five dominant species compared to the six which satisfied the criteria in 2012. Individual site dominant species were limited to the top five species with the maximum of six for some sites. Maximum of six dominant species were selected if two species tied on the ranking or the sixth one was one of the five dominant species for the reservoir. Site 6 was an exception as only five species occurred on site. For this site the upland site dominant species selection criteria was used.

2.5 Vegetation Mapping

Vegetation mapping utilized the baseline data parameters and TIN created in 2009. Using the polygons delineated in 2009, any changes in size, position, or composition of plant communities were updated to reflect 2015 plant communities. The vegetation type (herbaceous, shrub, tree, bare) and community (community composition by dominant cover) codes established in 2009 were used in the 2015 analysis with secondary or tertiary cover changed when required The dominant species (highest per cent cover regardless if it was vegetation, bare ground, wood, etc.) was used to distinguish between communities within a vegetation type. The original codes were utilized from 2009 and 2012; with two additional codes added in 2015. The additional communities were:

- H16 – Silvery hair-grass (*Aira caryophyllea*); and
- TR2 – Other tree or shrub species greater than 200 cm in height.

Bare (barren) ground was given a vegetation type code (Bare) and broken into two communities, Bare one (B1) was bare ground with dominant cover by bare ground, rock, wood, watercourse, etc., and Bare two (B2) was bare ground with trace amounts of vegetation (for area of polygon) with species listed in dominant 2nd and/or 3rd (Table 2-2). This was consistent with 2009 and 2012 methods. B2 vegetation was less than 25 percent cover for the delineated area. The dominant species are listed using the seven letter code, first four letters of genus and first three letters of scientific species name. A complete list of common and scientific names and codes are included in Appendix 1.

The vegetation type and communities polygons from 2012 were layered over 2015 ortho-photos and coded utilizing an ArcGIS geodatabase. Polygons were changed to record new size and/or any changes in dominant species noted on the ortho-rectified photos when change occurred. The major attributes included: plant community (vegetation type); communities dominant species one, two, and three; polygon area; site area; site aspect; transect line location (UTM coordinates); and transect line aspect (recorded as magnetic north bearings). The complete list of fields is located in the meta-data imbedded in the GIS files. This was consistent with the methods used in 2012 (Polzin and Rood 2013).

Table 2-2: Vegetation type and community codes used for air photo mapping and the main dominant species associated with the code.

Vegetation Type	Code	Community
Herbaceous (H)	H1	Common horsetail (Equi_arv.) (1)
	H2	Beaked sedge (Care_utr) (2)
	H3	Smartweed (Poly_lap) (3)
	H4	Grass (any species without a code) (4)
	H5	Narrow-leaved collomia (Coll_lin) (5)
	H6	Small-flowered bulrush (Scir_mic) (6)
	H7	Lambs quarters (Chen_alb) (7)
	H8	Spotted knapweed (Cent_mac) (8)
	H9	Yellow mountain avens (Drya_dru) (9)
	H10	Evening primrose (Oeno_vil) (10)
	H11	Yellow monkey-flower (Mimu_gut) (11)
	H12	Black cottonwood (Popu_tri) (<50cm tall) (12)
	H13	Nodding wood-reed (Cinn_lat) (13)
	H14	Wormseed mustard (Erys_che) (14)
	H15	Mouse-eared chickweed (Cera_vul) (15)
	H16	Silvery hair-grass (Aira.car) (16)
Shrubs (SH)	SH1	Black cottonwood (50 to 200 cm tall) (1)
	SH2	Willow – (50 cm to 200 cm tall) (2)
	SH3	All other dominant species (50 cm to 200 cm tall) (3)
Trees (TR)	TR1	Black cottonwood and shrubs (>200 cm) (1)
	TR2	All other dominant species (>200 cm) (2)
Bare (B)	B1	Bare ground – type listed under Dom1, 2, &/or 3 by abundance (wood – watercourse – bare ground) (1)
	B2	Bare ground with trace vegetation – dominant trace species listed 2nd and 3rd (2)

Summaries of areas (ha) for each vegetation type (herb, shrub, tree, and bare) and each community from the mapping data was completed for the "high potential" sites as required by TOR (BC Hydro 2009). However, area and cover type information is located in the GIS files for all 13 sites. The summaries for analyses were organized by three factors, by individual sites and total of the nine sites combined. Data summaries for the drawdown zone from vegetation mapping included:

1) Areas (ha) for each vegetation type and each community that occurred at each site;
2) Areas (ha) for each bare ground type that occurred for each site; and
3) Total area (ha) of all vegetation and bare ground at each site.

A summary of the Duncan Reservoir elevation analysis was completed for the 2014 reservoir levels with 2014 vegetation growing season to determine "high" potential for enhancement sites as identified in the TOR (BC Hydro 2009). The 2014 reservoir levels was selected as it was the last inundation cycle that impacted the 2015 vegetation captured in the air photos. The 2014 Alt S73 operating regime influenced the species and spatial distributions recorded in the spring of 2015 and represents the changes that occurred since the 2012 results. The 2009 data summaries reflect 2008 operating regime

impacts since the vegetation mapping was completed before inundation from the 2009 regime. As a result, baseline data is not from Pre-Alt S73 rather it is after the first year of initiation. A qualifying statement explaining this was included in the Polzin et al. (2010) report.

2.6 Ground Level Photo-Monitoring Points

The photo-monitoring methods used in 2009 (Polzin et al. 2010) were used in 2015. The photo-monitoring points, set-up on transect lines established in 2009 and 2012, had repeat photography in 2015. Photograph monitoring occurred at every two metre change in elevation along the transect lines. Five pictures were taken at each point, resulting in numerous photos, which are provided as contact sheets in Appendix 6. Three photos per transect line from 2012 were compared with 2015 in this report, but all photos for 2015 are on contact sheets in Appendix 6.

Upland photo monitoring was not structured the same as the reservoir. Due to the dense canopy cover and shrub layers, photos were taken to show the vegetation as best as possible. The 2015 photos are included in the photo documentation and contact sheets in Appendix 5 and Appendix 6.

2.7 *Factors Presented for Summary Report*

2.7.1 Physical factors

Physical factors were not investigated in 2015. The 2009 investigation into the physical factors identified three primary factors, elevation, site, and substrate texture. These were used for the summaries for 2015. For complete methods used for physical factor investigation see Polzin et al. (2010).

Elevation was developed into two elevation measures. The elevational positions were grouped within 1 m increments, providing an ordinal scale. This approach provided a more complete factorial matrix, which will enable the detection of interactions between elevation and inundation duration. The TOR (Terms of Reference, BC Hydro 2009) specified analyses for the eight metre drop in elevation for the drawdown zone but required a ten metre drop in elevation for data collection. Therefore most graphs show the eight metre change but some display the ten metre change in elevation.

The grouped elevations were as follows:

- -1 m = 0 (full-pool) to 1 m below full-pool (576.7 to 575.7 m);
- -2 m = -1 to -2 m (575.7 to 574.7 m);
- -3 m = -2 to -3 m (574.7 to 573.7 m);
- -4 m = -3 to -4 m (573.7 to 572.7 m);
- -5 m = -4 to -5 m (572.7 to 571.7 m);
- -6 m = -5 to -6 m (571.7 to 570.7 m);
- -7 m = -6 to -7 m (570.7 to 569.7 m);
- -8 m = -7 to -8 m (569.7 to 568.7 m);
- -9 m = -8 m to -9 m (568.7 to 567.7 m); and
- -10 m = -9 m to -10 m (567.7 to 566.7 m).

Data were collected for the full 10 m change in elevation (specified in the 2009 TOR) but the TOR (2009) also indicated that habitat productivity be assessed for an elevation of

approximately -8 m below full-pool. This resulted in each elevation band represented by the end elevation when represented in a graph for 1 to 8 m change in elevation.

Elevation was estimated for each quadrat based on linear interpolation between the survey points from 2009 and 2012. Detailed survey methods are located in Polzin et al. (2009) and Polzin and Rood (2013). This information was used to create the grouped elevations listed above.

Site was the term for each of the 12 spatial locations and study areas along the reservoir. Two to four transects were implemented at each site. This physical factor utilized all of the quadrats from two or more transects for each particular site. Twelve sites were investigated, but we retained previous numbering and thus included Sites 1 through 7, and 9 through 13, since the pre-assigned Site 8 was excluded from field sampling. Site 8 was excluded due to an error in the TOR (2009) for the site coordinates, which resulted in insufficient coverage by the aerial photography in 2009.

Substrate Texture Index (STI) which will be used for substrate factor analysis in 2018, was calculated for area based on field estimated per cent cover of silt, sand, gravel, cobble, and boulder along transects (referenced to metre distance from POC). These sediments were assigned scores of 1 to 5, respectively, and the STI was calculated as the sum of the proportion cover (decimal value) x score, for the five sediment classes. The STI value was rounded to 0.1 and was treated as a scale measure in 2009, with 41 possible values (1.0 to 5.0) and the data will be used in the 2018 hypotheses testing. This was consistent with the methods used in 2009.

2.7.2 Species Richness and Diversity

Species richness is the number of different species recorded within a quadrat or along a transect line. Diversity takes into account species richness as well as abundance. Computation of the Shannon-Wiener Diversity Index (H') or 'Shannon' indices for the sites was completed to provide an integrative measure of diversity. Midpoints of per cent cover classes were used as the measure of abundance. While some diversity measures require count data, the Shannon Index can be used with any form of data. For diversity, the Shannon Index (H') was calculated as follows:

$$H' = -\sum_{i=1}^{s} p_i \log_e p_i$$

where: p_i = proportion of the i^{th} species
s = the number of species in the community

This index increases with increasing species richness (number of species) and with increasing species evenness (abundance), the relative representation across the species. If there is only one species occurring within the quadrat the diversity is zero.

2.8 Data Analyses

The data analyses were limited to comparison to 2012 and 2009 when applicable. Factor analysis for multivariate analysis of variance was not required for this intermediate report. Summary analysis concentrated on the three main factors identified from full factor analysis in 2009 (Polzin et al. 2010). These were elevation, site, and substrate texture index. Elevation analysis was the main focus as vegetation elevation is directly linked to the reservoir level.

2.8.1 Summary and Comparative Data Analyses

Statistical analyses, including descriptive statistics, were conducted using SigmaPlot 12.5 (Systat Software Inc.San Jose California USA) and all tests were run at an alpha of 0.05. At the reservoir mapping level all site data included area in hectors per vegetation community and bare ground groups. At the field level, transect level vegetation cover (abundance) was measured as per cent cover of the quadrat used for sampling. Comparative analyses used ANOVA and/or Paired-Samples T-Tests. If the normality test failed for the paired samples being tested, the Wilcoxon Signed Rank Test was used instead. Samples were paired between years for sites.

Paired comparison between 2009 with 2012 had a reduced data size because three new transect lines were added that could not be directly compared, and extensions to transect lines in 2012 had no comparison to 2009 data. Consequently, we did not reduce the 2015 data set to match the 2009 set for paired quadrats along transect lines; but, we used paired sample tests for quadrat data along transect lines, between 2012 and 2015 since these had the same data sets. The comparison between 2015 and 2009 applied mean comparisons at the site level not for paired quadrat samples.

Analyses of 2015 data used the complete data sets for comparison between elevation, site, and substrate texture index. Regression analyses were used for vegetation cover and species diversity versus surface substrate index. Regression analyses were used for diversity per site for 2009 compared to 2012 and 2015.

3.0 RESULTS

3.1 Vegetation Mapping

Aerial photograph delineation of the vegetation type 'Bare' (including B1 and B2) showed increases across years for total area of bare ground (rock, wood, bare ground, water etc.) for some sites (Figure 3-1). Sites 2, 4, 5, 9, 10, and 13 had the largest increases in bare ground as compared to 2012 and 2009. Conversely, the vegetation type 'Herbaceous' displayed decreases in area compared to previous years. The largest decreases in herbaceous types occurred at the same sites that experienced the largest increases in bare ground area indicating transitions between these two cover types. The 'Shrub' vegetation type had small total area of cover when it occurred on a particular site from the beginning of the study. Similar to previous years, there was a decrease in overall shrub cover at the sites, with sites 2, 5, 7, 11, 13, and 14 displaying the largest decreases. The 'Tree' vegetation type (height >2.0 m) only occurred at Site 2. It represented a very small area in 2009 (0.0034 ha) which increased to 0.16 ha in 2012 and decreased slightly in 2015 (0.12 ha) (Table 3-1 for summary and Appendix 3 for full table). In 2015, Site 11 had a tree delineated polygon of 0.0047 ha which had not developed in size to be categorized as a tree polygon following detection in the air photos in 2009 or 2012.

Generally, total 'bare ground' increased since 2009 while total 'Shrub' declined after 2012 (Table 3-1). The total 'Tree' areas were similar in 2015, as compared to 2012, and both years displayed an increase compared to 2009. Herbaceous cover decreased since 2015.

Table 3-1: Summary table of vegetation types and dominant communities in the herbaceous vegetation type and notable communities by area.

Vegetation Type	2009 (ha)	2012 (ha)	2015 (ha)	Comment
Total Bare	15.7	24.2	57.9	Steady increase since 2009
Total Shrub	1.52	2.76	0.93	2012 > 2009, 2015 < 2009 & 2012
Total Tree	0.0032	0.16	0.12	2015 similar ton 2012, both > 2009
Herbaceous				
H1 (horsetail)	28.6	27.6	25.7	Slight decrease since 2009
H2 (sedge)	1.4	1.2	0.3	Decrease since 2009
H4 (grasses)	30.7	7.0	11.7	2015 & 2012 < 2009
H7 (lamb's-quarter)	7.1	0.0	0.0	Absent in 2012 and 2015
H8 (knapweed)	0.1	0.0	0.0	Absent in 2012 and 2015
H11 (monkey-flower)	3.5	3.1	0.03	2015 & 2012 < 2009
H15 (chickweed)	0.0	25.75	0.0	Present in 2012 (annual)
Total Herb	85.4	75.4	43.6	Steady decrease since 2009

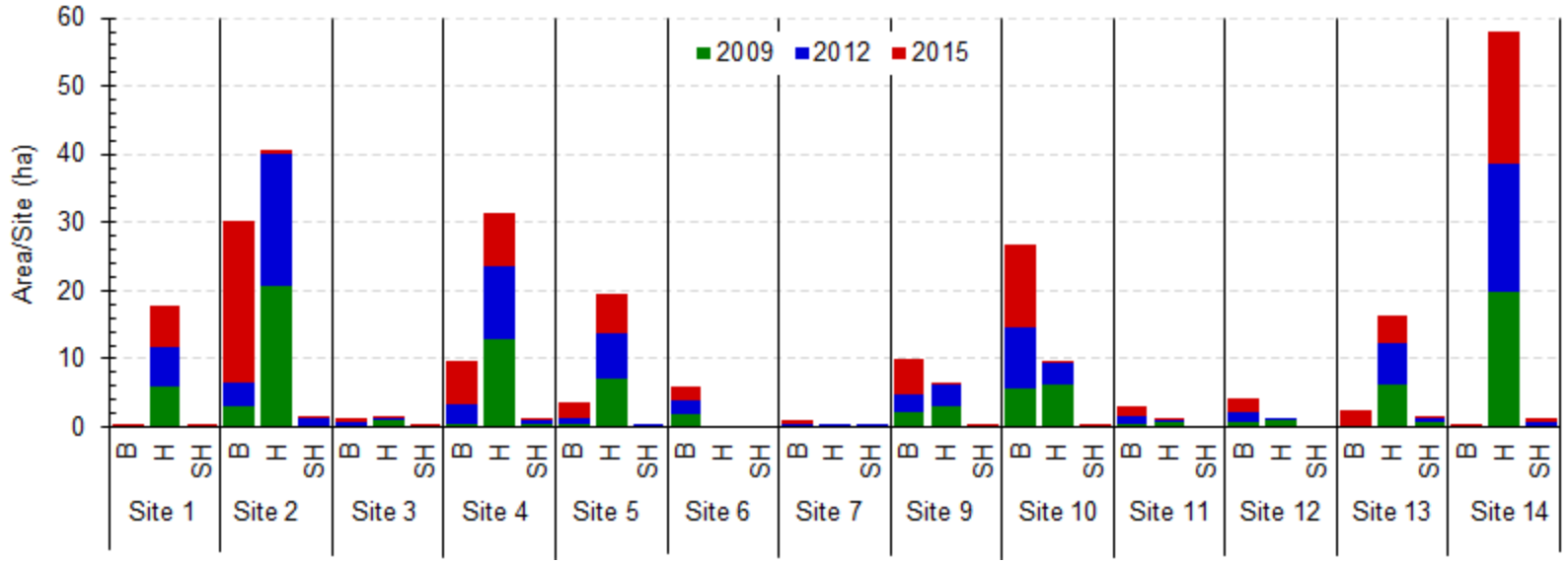


Figure 3-1: Total area (ha) per site for B – bare ground, H – herbaceous cover, and SH – shrub cover for 2009, 2012 and 2015

There was a significant decrease in vegetated ground by area in 2015, as compared to 2009 (Linear regression for the vegetated area between 2009 and 2015 was P = 0.02, *F* = 6.3 and *df* = 15 R^2 = 0.31).The trendline R^2 = 0.89 for both the vegetated and the bare ground. The percentage of bare area (ha) was 56.4 per cent of the total area in the study in 2015 compared to 15.3 per cent bare in 2009. The per cent of vegetated area (all vegetation types) decreased from 84.7 per cent of area in 2009 to 43.5 per cent area in 2015 (Figure 3-2).

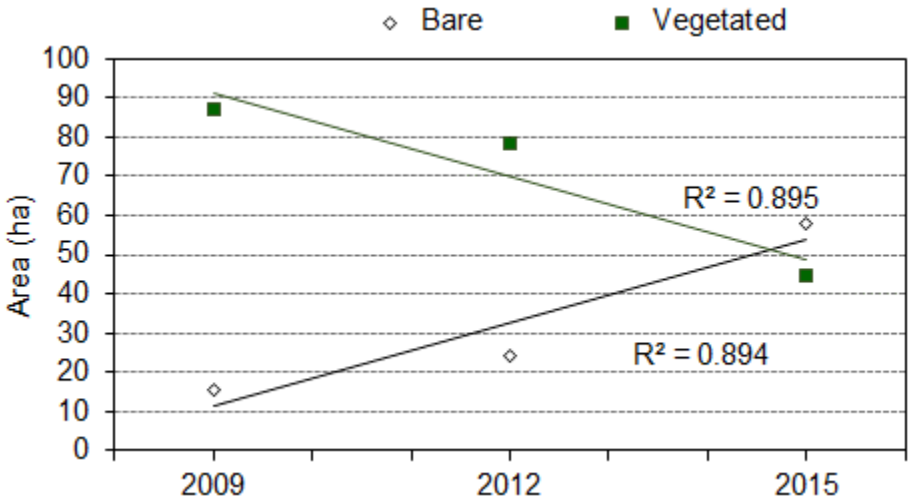


Figure 3-2: Comparison of area of bare and vegetated ground cover for the reservoir (total area 102.59 ha) for 2009, 2012, and 2015 sampling years.

The herbaceous plant community by dominant species showed evidence of differences in 2015 as compared to 2012 and 2009 (Table 3-1 and Appendix 3). The horsetail (*Equisetum arvense*) community H1 has had similar area coverage since 2009. The wormseed mustard (*Erysimum cheiranthoides*) community H15 did not occur in 2009 and there was a large increase in 2015 (3.74 ha) compared to 2012 (0.28 ha). Wormseed mustard occurred at all sites even in 2009 but was not a dominant plant in the herbaceous communities in 2009.

In 2009, the H4 community was assigned for any grass species dominating a community. At the time there were multiple dominant grass species at different sites and these were combined to provide H4. In 2012 and 2015, nodding wood-reed (*Cinna latifolia*) dominated the reservoir when grass communities occurred and a new community code was added to the list to reflect this. In 2015 silvery hair-grass (*Aira caryophyllea*) dominated some reservoir sites and was assigned a new community code. However, when the grass dominated communities are combined and compared to H4 there was a decrease in grass dominated communities since 2009 (30.7 ha to 11.7 ha).

All other dominant herbaceous communities declined or disappeared in 2015, as compared to 2009. The plant species still occurred but were not the dominant species of those communities. An important wetland/riparian community (H2 sedge) has been declining since 2009, dropping from 1.40 ha to 0.32 ha by 2015. The dominant sedge species was beaked sedge although other species occurred as well. Another wetland/riparian community, H6 (small-flowered bulrush) also declined from 0.96 ha to 0.14 ha. H14 (wormseed mustard) is the only herbaceous plant community to increase in area, rising to 3.7 ha in 2015 as compared to 0.3 ha in 2012 (Appendix 3).

3.1.1 Reservoir Levels 2014

The 2015 assessment used the 2014 reservoir levels as theses represented the prior inundation cycle, which influenced the 2015 vegetation. Reservoir fill levels were analysed for the growing season, starting in April 2014 and extending to the end of October 2014.

The water levels at the 85th percentile were:

- 576.0 m for 2014;
- 575.5 m for 2011; and
- 575.0 m for 2009.

The areas for each site exposed for 85 to 100 per cent of the growing season for the high riparian potential for enhancement sites were compared between year's and shows that the area exposed at the 85th percentile has been decreasing for each site for each year sampled (Figure 3-3).). Site 6 experienced the smallest decrease but Site 6 has had almost no vegetation cover since 2009. Data for each week and site is located in Appendix 2. The decrease in area for the 85th percentile has significantly decreased from 2009 and from 2011 ($P < 0.00$, $t = 7.3$, $df = 8$; and $P < 0.00$, $t = 13.9$, $df = 8$ respectively). The reservoir mean weekly levels have been graphed to show the timing and duration of inundation related to the reservoir drawdown zone elevations (Figure 3-4).

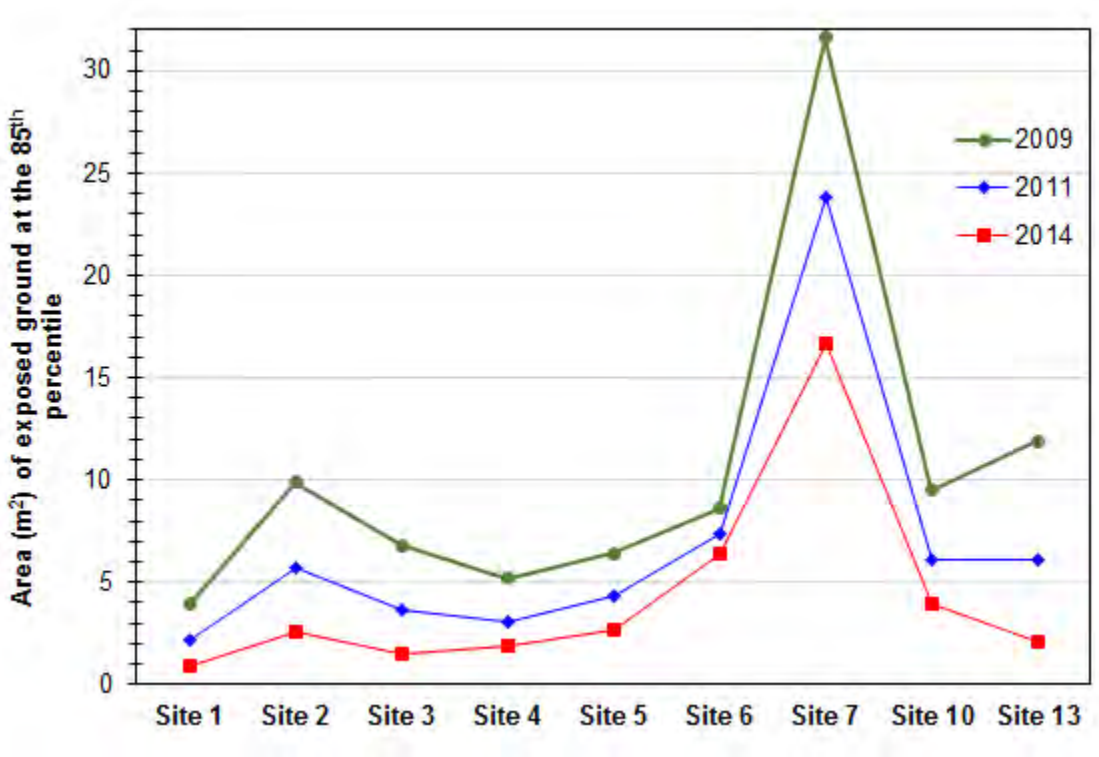


Figure 3-3: The per cent of the site within the drawdown zone that was exposed for 85 to 100 per cent (85th percentile) of the growing season for 2009, 2011, and 2014

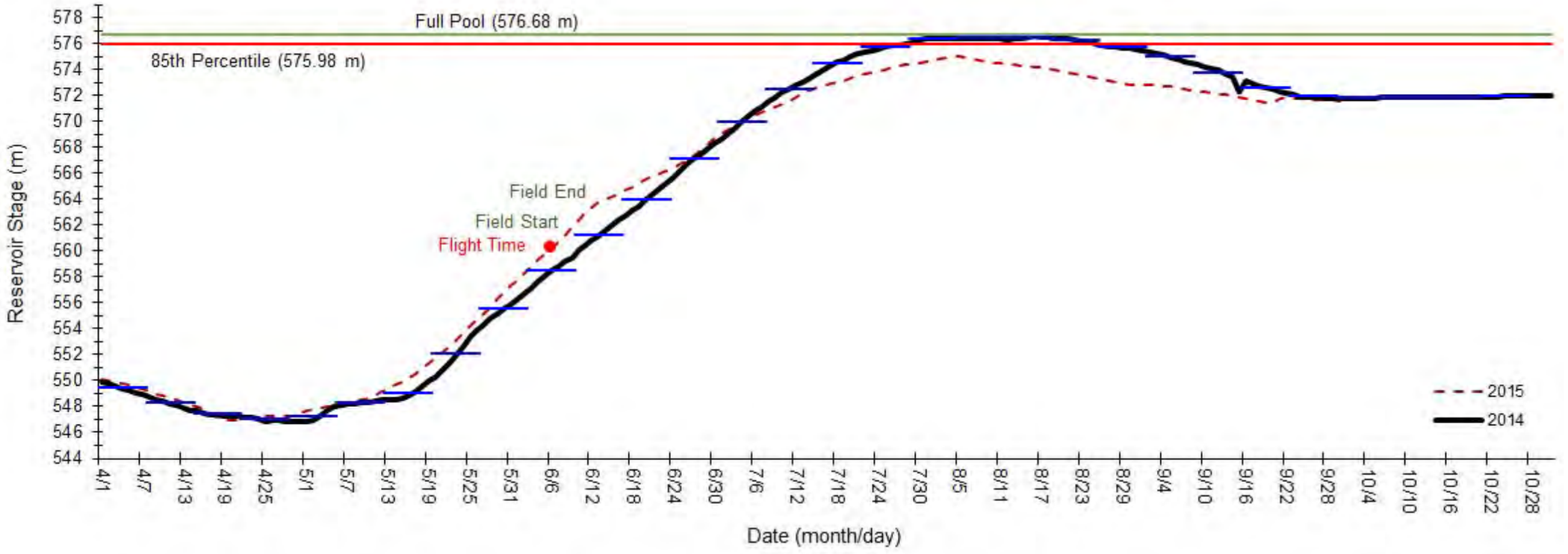


Figure 3-4: **2014 reservoir stage during the growing season (April to September 29) (solid black line) with the average weekly stage (26 weeks; short blue line) and the 85th percentile level (red line). Flight times relative to reservoir stage, as well as field data collection times are indicated as red and green marks, respectively and correspond to the 2015 reservoir stage (dashed line). Full-pool, which is upper limit of the reservoir water level and the start of the study area, is shown as a green line.**

3.1.2 Reservoir Levels 2015

The 2014 fill regime shows that full-pool was not quite reached. In contrast, in 2015, it remained 1.68 m below full-pool, or lower, and was thus much lower than for the previous years of the study (Figure 3-5). The rapid increase in reservoir stage and the surcharge above full-pool in 2012 appeared to affect vegetation cover within a band one metre below full-pool area in the 2015 field inventory.

Note the above full-pool peak that occurred in 2012. Precipitation patterns in 2012 resulted in flood control measures to help reduce flooding downstream of the Duncan Reservoir. Extreme precipitation levels in June resulted in the reservoir reaching full-pool July 21, one week and four days earlier than in 2011 and four weeks earlier than in 2009. The reservoir fill level exceeded full-pool July 22 and stayed above full-pool until July 25 in 2012.

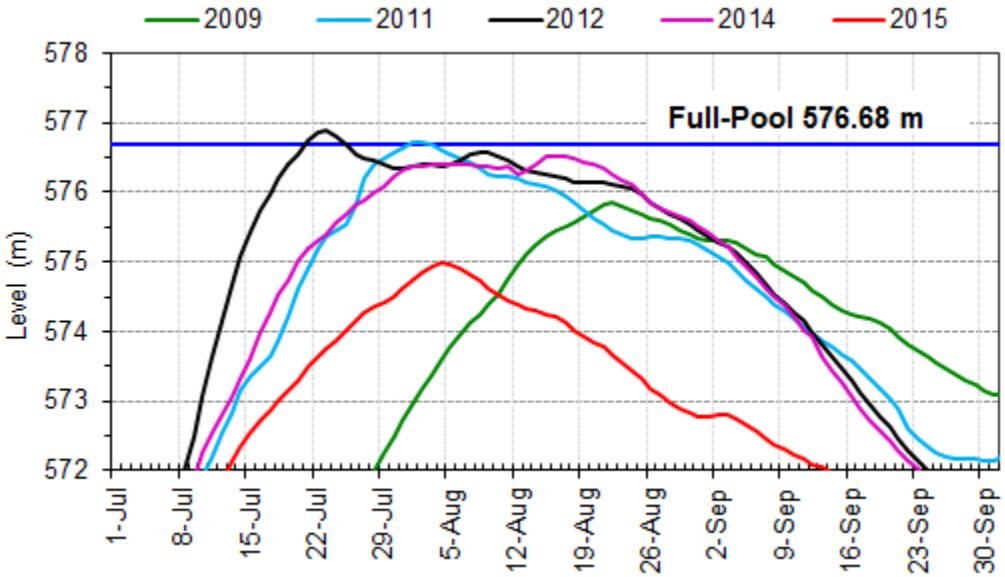


Figure 3-5: Mean Daily Water Levels (m) for Duncan Reservoir at Duncan Dam (WSC Station 08NH127) for July 1 to September 30.

3.1.3 Weather

Weather data in Figure 3-6 show total monthly precipitation and mean monthly temperatures for 2012, 2014, and 2015. An early spring, with hot weather intervals occurred in 2015. February mean monthly temperature was the highest of the three sampling years but similar to 2010 (non-sampling year) for February, March, and April. The 2015 mean temperatures increased in May and June compared to 2010. Figure 3-7 shows the variation in daily maximum temperatures in May and June compared to 2012 and 2014, and the multiple days when temperatures remained higher during the same time period in 2015.

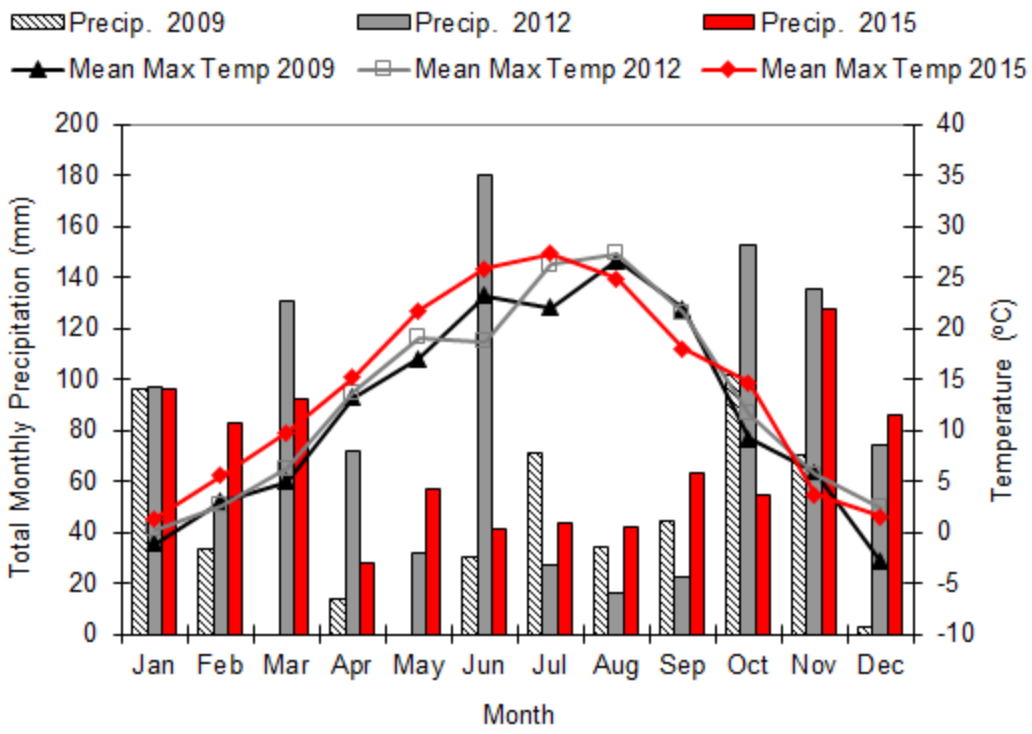


Figure 3-6: Mean monthly temperature and monthly total precipitation at the Duncan Lake Dam (1142574) climate station.

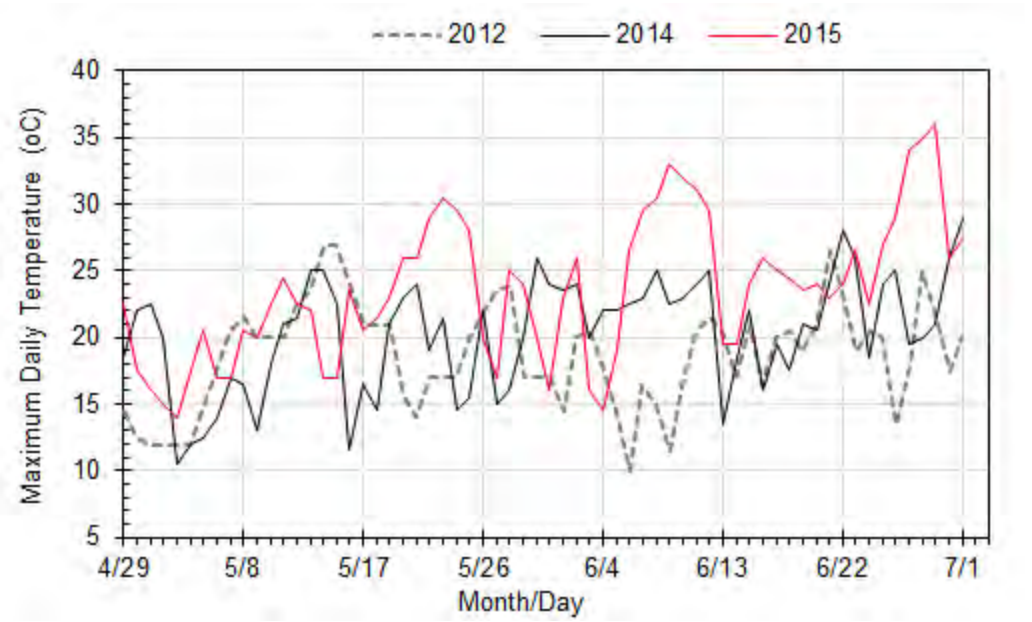


Figure 3-7: Daily maximum temperatures for May and June for 2012, 2014, and 2015 (Duncan Lake Dam station 1142574).

The comparison of the weather data for the three years of the field study (2009, 2012, and 2015), shows that 2015 was the warmest of the three years for the plant growth season within the drawdown zone (April to end of June). The 2012 field season had the highest

precipitation during the growing season and 2009 had the coolest spring leading up to the end of the growth season (June), prior to inundation (Figure 3-8).

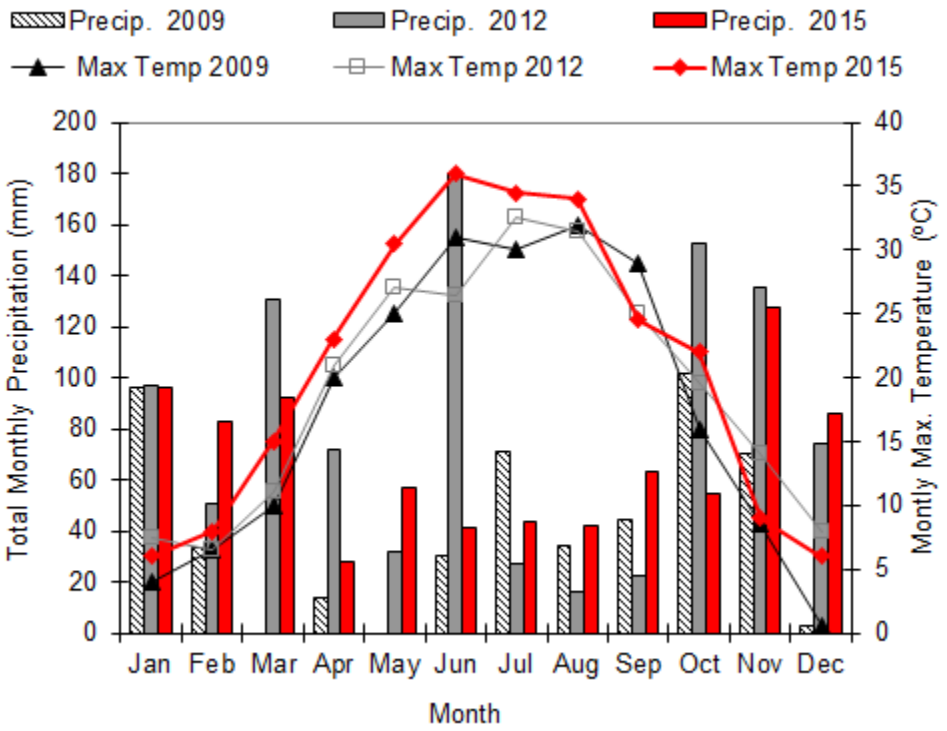


Figure 3-8: Monthly maximum temperatures and total monthly precipitation for monitoring years 2009, 2012, and 2015.

3.2 Site Description Summaries

Site descriptions were provided by Polzin et al. (2010). Changes to transect line lengths and additional transect lines added to some sites were included Polzin and Rood (2013). Appendix 1 shows site position on the reservoir, aspect, number of transect lines, slope, and length of the transect lines.

3.3 Ground Level Photograph Monitoring Points and Upland Vegetation Summaries

The drawdown zone had three comparison photos between 2012 and 2015 at the same photo points illustrated and included for each transect line following each site summary. A summary table for each site includes 2012 results for comparisons indicating differences or similarities between years, as illustrated with the photograph comparisons. The upland zone has a summary table included, photos are located in Appendix 6.

A general site description, characteristics, and possible influences in the drawdown zone are provided in Appendix 1.

The individual sites summary tables list information for the site as well as for the reservoir (total of all sites). For the individual Sites this included:

- Dominate species;
- Cumulative cover;
- Per cent of the site covered by the species;
- Per cent of the total reservoir cover represented by the amount at the site; and
- Site plant richness for 2009, 2012, and 2015.

For the Reservoir (all sites) tables included:

- Dominate plant species;
- Cumulative cover; and
- Reservoir plant species richness.

The information for the individual site with reservoir data is found in Table 3-2 to Table 3-13. A “W” prior to the species code name indicates weedy species (Royer and Dickinson 1999).

Upland summary tables for each site include dominant species, cumulative cover, species richness, and site cover by upland for Tree, Shrub, and Herb plots.

Site 1 was the most southern site (closest to the Dam) and has the developed Glacier Creek Forest Recreation Site in the sampled upland zone above full-pool (Appendix 1). Site 1 summary is located in Table 3-2.

Table 3-2: The dominant species, cumulative cover, species richness, and overall reservoir totals for Site 1 in 2015. Site cover by reservoir cover is the percentage of the individual site's species cumulative cover contributed to the reservoir cumulative cover (site species, cumulative cover/reservoir species cumulative cover).

Dominant Species for Site 1	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Equi_arv (N)	235.2	16.2	2.1	h_W_Equi_arv (N)	3,443.7
h_W_Erys_che (N)	178.1	12.3	1.6	h_W_Poly_lap (N)	943.4
h_W_Poly_lap (N)	157.9	10.9	1.4	g_Cinn_lat (N)	770.6
h_W_Cera_vul (N)	140.5	9.7	1.3	h_Care_utr (N)	703.4
g_Cinn_lat (N)	122.9	8.5	1.1	g_Aira.car (E)	530.2
g_Aira_car (E)	117.7	8.1	1.1		

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	22	52
Shrub	4	0	2	13
Tree	5	3	4	8
Total	29	20	28	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 1. Upland transect line lengths were: #1 – 0-31m, #869 – 0-24 m. No change from 2012 except growth of trees and shrubs.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Pseu_men	210	49.9	20.7	T = 9
	Thuj_Pli	65.2	15.5	3.8	
	Lari_Occ	55	13.1	95.7	
	Betu_pap	40.1	9.5	7.0	
	Pinu_con	30.1	7.2	100.0	
S 8 m^2	Rubu_par	67.5	68.9	24.8	S = 9
	Amel_aln	5.1	5.2	12.7	
H 1 m^2	Fest. Combined	102.5	31.5	97.6	H = 27
	Pter_aqu	22.6	6.9	59.9	
Upland Species Richness for Reservoir = 76 - Tree = 11, Shrub = 26, Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 1 had two transect lines, Transect #1 and Transect #869.

Site 1 - Transect #1 (320 m long)

2012 Herb quadrat at 86.6 m mark.

2015 Herb quadrat at 86.6 m mark.

2012 Looking down line at 87.6 m.

2015 Looking down line at 87.7 m.

2012 Looking down reservoir at 87.7 m.

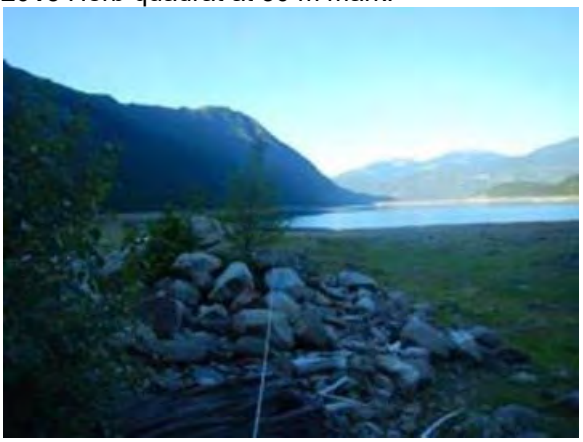
2015 Looking down reservoir at 87.7 m.

Site 1 - Transect #869 (134 m long)

2012 Herb quadrat at 30 m mark.

2015 Herb quadrat at 30 m mark.

2012 Looking down line at 1 m.



2015 Looking down line at 1 m.

2012 Looking up reservoir at 1 m.

2015 Looking up reservoir at 1 m.

Site 2 was located to the north and on the opposite side of Glacier Creek from Site 1, with an established recreational road access to the site. This area was frequently utilized by off road vehicles, as evidenced by the numerous tire tracks in the drawdown zone. Evening primrose (Oeno_vil) was the third ranked dominant species in 2012 for the site but was reduced to fourth in 2015 (Table 3-3). It occurred mainly in one large patch and the majority (84 per cent) of the total reservoir cover for this species was located at Site 2. Reed-canary grass (*Phalaris arundinacea*) is not listed as a noxious weed by the *B.C. Weed Control Act*, but is a weedy species of concern. In 2009, S2 had reed-canary grass recorded along one transect line per site with a per cent cover (1 m^2 quadrat) of 2.5 per cent. In 2015 no reed-canary grass was recorded. Change in tag #'s: 701 = 884, 702 = 885, and 703 = 822. Summaries are presented in Table 3-3.

Table 3-3: The dominant species, cumulative cover, species richness and overall reservoir totals for Site 2 in 2015.

Dominant Species for Site 2	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
t_Popu_tri (N)	325.0	24.1	2.9	h_W_Equi_arv (N)	3,443.7
h_W_Poly_lap (N)	135.4	10.1	1.2	h_W_Poly_lap (N)	943.4
h_Coll_lin (N)	115.5	8.6	1.0	g_Cinn_lat (N)	770.6
h_Oeno_vil (N)	110.0	8.2	1.0	h_Care_utr (N)	703.4
h_Care_utr (N)	90.2	6.7	0.8	g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness	
	09	12	15		
Herb	20	17	25	52	**Coding:** h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.
Shrub	4	0	2	13	
Tree	5	3	3	8	
Total	29	20	30	73	

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 2. No change noted except for growth of trees and shrubs. Upland transect line lengths were: #884 – 0-25m, #885 – 0-20 m, and #822 – 0-24 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Pseu_men	300	49.8	29.6	T = 5
	Popu_tri	200	33.2	66.1	
	Betu_pap	55.1	9.1	9.6	
S 8 m^2	Amel_aln	32.5	21.3	81.0	S = 9
	Popu_tri	65	42.6	43.6	
	Rubu.par	30	19.6	11.0	
H 1 m^2	Moss	172.5	55.1	28.5	H = 22
Upland Species Richness for Reservoir = 76 - Tree = 11, Shrub = 26, Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 2 had three transect lines, Transect #884, Transect #885, and Transect #822.

Site 2 - Transect #884 (304 m long)

2012 Herb quadrat at 57 m.

2015 Herb quadrat at 57 m.

2012 Looking up line at 29 m.

2015 Looking up line at 29 m.

2012 Looking down line at 29 m.

2015 Looking down line at 29 m.

Site 2 –Transect #885 (388 m long)

2012 Looking down line at 1 m.

2015 Looking down line at 1 m.

2012 Looking up reservoir at 61 m.

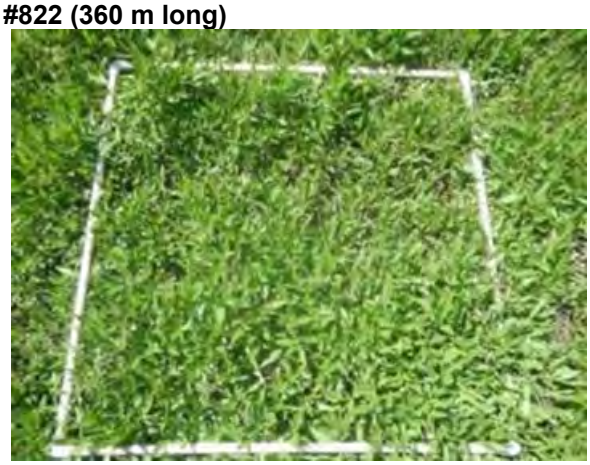
2015 Looking up reservoir at 61 m.

2012 Looking up line at 85 m.

2015 Looking up line at 85 m.

Site 2 –Transect #822 (360 m long)

2012 Herb quadrat at 29 m.



2015 Herb quadrat at 29 m.

2012 Looking up line at 11 m.

2015 Looking up line at 11 m.

2012 Looking down line at 30 m.

2015 Looking down line at 30 m.

Site 3 was located on a peninsula in an area referred to as the "Lower Arm", which occurs between Duncan Island and the eastern shore of Duncan Reservoir. No external influences were noted for this site. Reed-canary grass was recorded along transect line 812 within on quadrat at 2.5 per cent cover. See Table 3-4 for summaries of cover and species richness.

Table 3-4: The dominant species, cumulative cover, species richness and overall reservoir totals for Site 3 in 2015.

Dominant Species for Site 3	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
g_Cinn_lat (N)	170.1	24.9	1.5	h_W_Equi_arv (N)	3,443.7
h_Moss (N)	167.5	24.5	1.5	h_W_Poly_lap (N)	943.4
h_W_Equi_arv (N)	82.5	12.1	0.7	g_Cinn_lat (N)	770.6
h_W_Cera_vul (N)	52.7	7.7	0.5	h_Care_utr (N)	703.4
h_Plea_sch (N)	45	6.6	0.4	g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	19	52
Shrub	4	0	5	13
Tree	5	3	3	8
Total	29	20	30	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 3. No change noted except for growth of trees and shrubs. Upland transects lengths were: #704 – 0-25 m and #812 – 0-6 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Pseu_men Thuj_pli	127.5 83.5	55.2 36.1	12.6 4.9	T = 4
S 8 m^2	Acer_glab	15.0	75.0	85.7	S = 3
H 1 m^2	Moss	197.5	95.1	32.6	H = 6
Upland Species Richness for Reservoir = 76 – Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

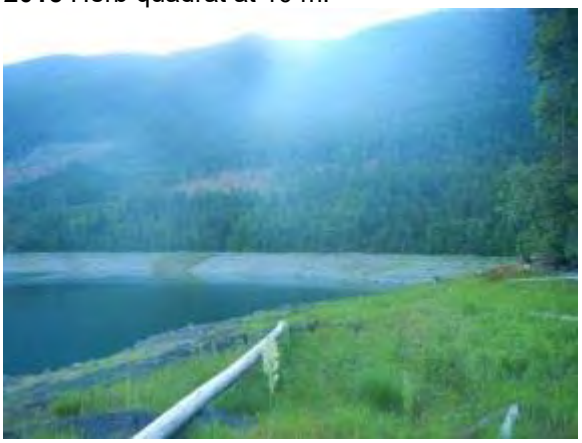
Site 3 had two transect lines, Transect # 704 and Transect # 812.

Site 3 – Transect #704 (52 m long)

2012 Herb quadrat at 10 m.

2015 Herb quadrat at 10 m.

2012 Looking up reservoir at 11 m.



2015 Looking up reservoir at 11 m.

2012 Looking up line at 17 m.

2015 Looking up line at 17 m.

Site 3 – Transect #812 (48 m long)

2012 Herb quadrat at 47 m.

2015 Herb quadrat at 47 m.

2012 Looking up line at 48 m.

2015 Looking up line at 48 m.

2012 Looking down line at 48 m.

2015 Looking down line at 48 m.

Site 4 was located on a long, narrow bay on the western side of a large island (Duncan Island). Duncan Island supports a private woodlot, and a number of permanent residences are located in the undisturbed upland above full-pool. See Table 3-5 for cover and species richness summary.

Table 3-5: The dominant species, cumulative cover, species richness and overall reservoir totals for Site 4 in 2015.

Dominant Species for Site 4	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Equi_arv (N)	262.6	35.9	2.4	h_W_Equi_arv (N)	3443.7
h_Moss (N)	122.5	16.8	1.1	h_W_Poly_lap (N)	943.4
h_Mimu_gut (N)	95.1	13	0.9	g_Cinn_lat (N)	770.6
g_Aira_car (E)	70.5	9.6	0.6	h_Care_utr (N)	703.4
				g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	17	52
Shrub	4	0	1	13
Tree	5	3	2	8
Total	29	20	20	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 4. No change noted except for growth of trees and shrubs. Upland transect line lengths were: #705 – 0-12 m and #706 – 0-6 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Thuj_pli Pseu_men Betu_pap	185 67.5 55	60.2 22.0 17.9	10.9 6.7 9.6	T = 3
S 8 m^2	Shep_can Thuj_pli	77.5 45	60.8 35.3	30.4 30.5	S = 4
H 1 m^2	Moss	85	70.8	14.0	H = 5
Upland Species Richness for Reservoir = 76 – Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 4 had two transect lines, Transect # 705 and Transect #706.

Site 4 – Transect #705 (71 m long)

2012 Herb quadrat at 29.5 m.

2015 Herb quadrat at 29.5 m.

2012 Looking up line at 30.5 m.

2015 Looking up line at 30.5 m.

2012 Looking down line at 30.5 m.

2015 Looking down line at 30.5 m.

Site 4 – Transect #706 (54.0 m long)

2012 Looking up reservoir at 22 m.

2015 Looking up reservoir at 22 m.

2012 Looking up line at 37 m.

2015 Looking up line at 37 m.

2012 Looking down line at 37 m.

2015 Looking down line at 37 m.

Site 5 was located in an area referred to as the "Upper Arm", which occurs between Duncan Island and the eastern shore of Duncan Reservoir. There was little evidence of recent human activity in the upland, since access to the site required "bushwhacking" through a previously logged area that was quite grown in. Well used game trails were evident while accessing the site. No creek influence was noted; however, there were large quantities of water seeping from the upland, forming extensive saturated areas that did not support vegetation. See Table 3-6 for cover and species richness summaries.

Table 3-6: The dominant species, cumulative cover, species richness and overall reservoir totals for Site 5 in 2015.

Dominant Species for Site 5	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Equi_arv (N)	270.0	23.9	2.4	h_W_Equi_arv (N)	3,443.7
g_Aira_car (E)	242.6	21.4	2.2	h_W_Poly_lap (N)	943.4
h_W_Poly_lap (N)	162.5	14.4	1.5	g_Cinn_lat (N)	770.6
g_Cinn_lat (N)	112.6	10.0	1.0	h_Care_utr (N)	703.4
h_W_Cera_vul (N)	75.5	6.7	0.7	g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness	Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.
	09	12	15		
Herb	20	17	16	52	
Shrub	4	0	2	13	
Tree	5	3	1	8	
Total	29	20	19	73	

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 5. No change noted except for growth of trees and shrubs. Upland transect line lengths were: #707 – 0-10 m and #813 – 0-12 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Thuj_pli	330.0	54.3	19.5	T = 7
	Betu_pap	140.0	23.0	24.3	
	Tsug_het	117.5	19.3	17.3	
S 8 m^2	Shep_can	122.5	45.3	48.0	S = 4
	Rubu_par	42.5	15.7	15.6	
H 1 m^2	Equi_arv	37.5	46.8	83.3	H = 7
	Linn_bor	15.0	18.7	23.0	
	Pter_aqu	15.0	18.7	39.8	
Upland Species Richness for Reservoir = 76 – Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 5 had two transect lines, Transect #707 and Transect #813.

Site 5 – Transect #707 (130 m long)

2012 Herb quadrat at 37 m.

2015 Herb quadrat at 37 m.

2012 Looking up line at 38 m.

2015 Looking up line at 38 m.

2012 Looking down reservoir at 106 m.

2015 Looking down reservoir at 106 m.

Site 5 – Transect #813 (71 m long)

2012 Herb quadrat at 4 m.

2015 Herb quadrat at 4 m.

2012 Looking down line at 5 m.

2015 Looking down line at 5 m.

2012 Looking up line at 48 m.

2015 Looking up line at 48 m.

Site 6 was located on the southern side of "Little Glacier Creek". The site was influenced by the creek and proximal to the Duncan River Forest Service Road. An overgrown skid trail and an abandoned camper indicated that this area was regularly visited by people before 2008. Vegetation on the site was sparse with the majority of the transect line covering bare ground (Table 3-7). The dominant species fireweed (Epil_ang) is an upland species and occurred within the -1 m elevation bracket.

Table 3-7: The dominant species, cumulative cover, species richness and overall reservoir totals for Site 6 in 2015.

Dominant Species for Site 6	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Epil_ang (N)	15	59.3	0.18	h_W_Equi_arv (N)	3,443.7
h_W_Poly_lap (N)	5.2	20.6	0.03	h_W_Poly_lap (N)	943.4
				g_Cinn_lat (N)	770.6
				h_Care_utr (N)	703.4
				g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	5	52
Shrub	4	0	0	13
Tree	5	3	0	8
Total	29	20	5	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 6. Transect Line 708 was reduced in length because of scour from Little Glacier Creek. Transect Line 814 had most of the ground cover because the bank slide for the 0 m mark to 10 m reducing cumulative cover for the upland cover for Site 6 in 2015. Upland transect line lengths were: #708 – 0-27 m and #814 – 0-5 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Thuj_pli Tsug_het	85.0 77.5	41.0 37.3	5.0 11.4	T = 4
S 8 m^2	Thuj_pli Shep_can	37.5 17.5	42.9 20.0	25.4 6.9	S = 5
H 1 m^2	Moss	52.6	100.0	8.7	H = 1
Upland Species Richness for Reservoir = 76 - Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 6 had two transect lines, Transect #708 and Transect #814.

Site 6 - Transect #708 (128.0 m long)

2012 Looking down line at 8 m.

2015 Looking down line at 8 m.

2012 Looking up line at 27 m.

2015 Looking up line at 27 m.

2012 Looking down reservoir at 27 m.

2015 Looking down reservoir at 27 m.

Site 6 - Transect #814 (35 m long)

2012 Looking down line at 8.7 m.

2015 Looking down line at 8.7 m.

2012 Looking down reservoir 1 m.

2015 Looking down reservoir 1 m.

2012 Looking down reservoir at 19.3 m.

2015 Looking down reservoir at 19.3 m.

Site 7 was located on a point of land bounded by Howser Creek to the north and the reservoir to west. An unofficial, but well used camp site was located in the upland above full-pool. Although Howser Creek is nearby, no creek influence was noted on the site itself. See Table 3-8 for cover and species richness summaries.

Table 3-8: The dominant species, cumulative cover, species richness, and overall reservoir totals for Site 7 in 2015.

Dominant Species for Site 7	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Equi_arv (N)	57.5	42.4	0.5	h_W_Equi_arv (N)	3,443.7
g_Cinn_lat (N)	35.4	26.1	0.3	h_W_Poly_lap (N)	943.4
h_W_Erys_che (N)	17.5	12.9	0.2	g_Cinn_lat (N)	770.6
t_Popu_tri (N)	15.0	11.1	0.1	h_Care_utr (N)	703.4
				g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness	Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.
	09	12	15		
Herb	20	17	6	52	
Shrub	4	0	0	13	
Tree	5	3	1	8	
Total	29	20	7	73	

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 7. Transect Line 3 had brush and trees cut down along the full-pool edge (human impact). No change noted except for growth of trees and shrubs for Transect Line 2. Upland transect line lengths were: #2 – 0-24 m and #3 – 0-7 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Pinu_mon	62.5	32.5	100.0	T = 5
	Betu_pap	37.5	19.5	6.5	
	Popu_tre	37.5	19.5	65.2	
	Popu_tri	37.5	19.5	12.4	
S 8 m^2	Popu_tri	47.5	24.7	26.0	S = 5
	Rosa_gym	52.5	27.3	95.5	
	Rubu_par	52.5	27.3	19.3	
H 1 m^2	Cent_mac	342.5	62.0	94.5	H = 11
Upland Species Richness for Reservoir = 76 - Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 7 consisted of two transect lines: Transect #2 and Transect #3.

Site 7 - Transect #2 (40 m long)

2012 Herb quadrat at 20 m.

2015 Herb quadrat at 20 m.

2012 Looking down reservoir at 21 m.

2015 Looking down reservoir at 21 m.

2012 Looking down line at 1 m.

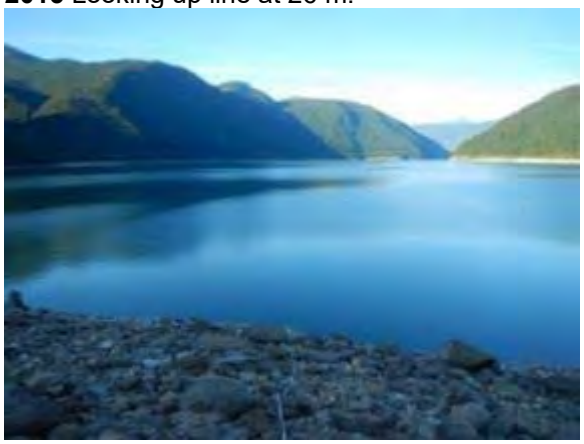
2015 Looking down line at 1 m.

Site 7 - Transect #3 (55 m long)

2012 Looking up line at 26 m.

2015 Looking up line at 26 m.

2012 Looking down line at 26 m.



2015 Looking down line at 26 m.

2012 Looking up reservoir at 26 m.

2015 Looking up reservoir at 26 m.

Site 9 was located on the north side of Clancy Creek. An unofficial camp site was located on the south side of the creek in the upland above full-pool and was accessed by an old road. Although Clancy Creek was nearby, no creek influence was noted on the site itself. See Table 3-9 for cover and species richness summaries.

Table 3-9: The dominant species, cumulative cover, species richness, and overall reservoir totals for Site 9 in 2015.

Dominant Species for Site 9	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Equi_arv (N)	390.2	32.8	3.5	h_W_Equi_arv (N)	3,443.7
h_Care_utr (N)	310.1	26.0	2.8	h_W_Poly_lap (N)	943.4
h_W_Poly_lap (N)	218.0	18.3	2.0	g_Cinn_lat (N)	770.6
s_Sali_beb (N)	85.0	7.1	0.8	h_Care_utr (N)	703.4
h_W_Chen_alb (N)	60.1	5.0	0.5	g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	9	52
Shrub	4	0	3	13
Tree	5	3	0	8
Total	29	20	12	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 9. No change noted except for growth of trees and shrubs. Upland transect line lengths were: #709 – 0-7 m, #710 – 0-13.5 m, #711 – 0-14 m, and #712 – 0-13 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Thuj_pli Betu_pap	475.0 130.0	56.7 15.5	28.0 22.6	T = 10
S 8 m^2	Pach_myr Thuj_pli	52.5 37.5	38.2 27.3	77.8 25.4	S = 6
H 1 m^2	Moss	80.0	90.9	13.2	H = 7
Upland Species Richness for Reservoir = 76 - Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 9 had four transect lines: Transect #709, Transect #710, Transect #711, and Transect#712.

Site 9 -Transect #709 (92 m long)

2012 Herb quadrat at 17 m.

2015 Herb quadrat at 17 m.

2012 Looking up reservoir at 18 m.

2015 Looking up reservoir at 18 m.

2012 Looking up line at 56 m.

2015 Looking up line at 56 m.

Site 9 - Transect #710 (107 m long)

2012 Looking up line at 14 m.

2015 Looking up line at 14 m.

2012 Looking up reservoir at 14 m.

2015 Looking up reservoir at 14 m.

2012 Looking down line at 14 m.

2015 Looking down line at 14 m.

Site 9 - Transect #711 (151 m long)

2012 Herb quadrat at 2 m.

2015 Herb quadrat at 2 m.

2012 Looking up line at 45 m.

2015 Looking up line at 45 m.

2012 Looking down reservoir at 45 m.

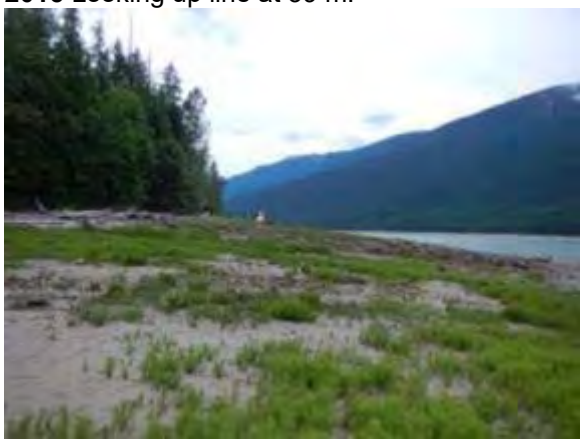
2015 Looking down reservoir at 45 m.

Site 9 - Transect #712 (168 m long)

2012 Looking up line at 39 m.

2015 Looking up line at 39 m.

2012 Looking down reservoir at 39 m.



2015 Looking down reservoir at 39 m.

2012 Looking up reservoir at 39 m.

2015 Looking up reservoir at 39 m.

Site 10 was located on both the north and south sides of Cockle Creek, although none of the transect lines intercepted the creek. An unofficial camp site was located on the north side of the creek in the upland above full-pool and was accessed by an old road, which ended at the reservoir, but did not cross the creek. Clancy Creek, which intersected the site, influenced transect #6, but not transects #713 and #714. See Table 3-10 for cover and species richness summaries.

Table 3-10: The dominant species, cumulative cover, species richness, and overall reservoir totals for Site 10 in 2015.

Dominant Species for Site 10	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Poly_lap (N)	145.3	21.7	1.3	h_W_Equi_arv (N)	3,443.7
h_Care_utr (N)	112.5	16.8	1.0	h_W_Poly_lap (N)	943.4
h_W_Erys_che (N)	102.5	15.3	0.9	g_Cinn_lat (N)	770.6
h_W_Equi_arv (N)	90.1	13.4	0.8	h_Care_utr (N)	703.4
h_Drya_dru (N)	40.0	6.0	0.4	g_Aira.car (E)	530.2
h_W_Rume_cri (E)	40.0	6.0	0.4		

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	15	52
Shrub	4	0	2	13
Tree	5	3	2	8
Total	29	20	19	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 10. Transect Line 6 had the last five metres of the line impacted by scour from Clancy Creek with very low vegetation cover to no cover along this section of the line compared to previous years. No change noted except for growth of trees and shrubs for the other two lines. Upland transect line lengths were: #713 – 0-14 m, #714 – 0-11 m, and #6 – 0-24 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Pseu_men	160.0	30.5	15.8	T = 7
	Thuj_pli	115.0	21.9	6.8	
	Tsug_het	115.0	21.9	17.0	
	Pice_gla	100.0	19.0	97.6	
S 8 m^2	Popu_tri	21.5	39.7	11.8	S = 9
H 1 m^2	Drya_dru	40.0	33.9	100.0	H = 10
	Moss	30.0	25.4	5.0	
Upland Species Richness for Reservoir = 76 - Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 10 had three transect lines: Transect #6, Transect #713, and Transect #714.

Site 10 - Transect #6 (185 m long)

2012 Herb quadrat at 2 m.

2015 Herb quadrat at 2 m.

2012 Looking down line at 3 m.

2015 Looking down line at 3 m.

2012 Looking down reservoir at 45 m.

2015 Looking down reservoir at 45 m.

Site 10 - Transect #713 (90 m long)

2012 Looking up line at 12 m.

2015 Looking up line at 12 m.

2012 Looking up line at 52 m.

2015 Looking up line at 52 m.

2012 Looking down reservoir at 52 m.

2015 Looking down reservoir at 52 m.

Site 10 - Transect #714 (84 m long)

2012 Herb quadrat at 15 m.

2015 Herb quadrat at 15 m.

2012 Looking up line at 16 m.

2015 Looking up line at 16 m.

2012 Looking down reservoir at 16 m.

2015 Looking down reservoir at 16 m.

Site 11 was located on the west side of Duncan Reservoir and was accessible only by boat. The site spanned the north and south sides of Idaho Creek, with transect line # 716 intercepting the creek. Idaho Creek, which intersected the site, was noted as an influence on the northernmost transect (#716), but not on the southernmost transect (#715). Reed-canary grass was recorded along transect 715 within four different quadrats with 15 per cent cover within each of the three quadrats and 2.5 per cent in the fourth quadrat (total cumulative cover of 47.5 per cent cover. In 2015 only one quadrat had 2.5 per cent cover within it. See Table 3-11 for cover and species richness summaries.

Table 3-11: The dominant species, cumulative cover, species richness, and overall reservoir totals for Site 11 in 2015.

Dominant Species for Site 11	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Equi_arv (N)	240.1	48.0	2.2	h_W_Equi_arv (N)	3,443.7
t_Betu_pap (N)	62.5	12.5	0.6	h_W_Poly_lap (N)	943.4
s_Corn_sto (N)	62.5	12.5	0.6	g_Cinn_lat (N)	770.6
h_Care_utr (N)	60	12.0	0.5	h_Care_utr (N)	703.4
h_W_Poly_lap (N)	32.6	6.5	0.3	g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	7	52
Shrub	4	0	1	13
Tree	5	3	1	8
Total	29	20	9	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 11. Transect Line 716 had dead shrubs and small trees that were alive and healthy in 2012. No change noted except for growth of trees and shrubs for Transect Line 715. Upland transect line lengths were: #715 – 0-7 m and #716 – 0-7 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Thuj_pli	100.0	44.9	5.9	T = 5
	Acer_gla	65.0	29.2	54.2	
	Corn_sto	40.0	18.0	29.6	
S 8 m^2	Rubu_par	62.5	58.1	22.9	S = 5
	Ribe_lac	37.5	34.9	88.2	
H 1 m^2	Gymn_dry	15.0	85.2	100.0	H = 3
Upland Species Richness for Reservoir = 76 - Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 11 had two transects lines: Transect #715 and #716.

Site 11 - Transect #715 (67 m long)

2012 Herb quadrat at 13 m.

2015 Herb quadrat at 13 m.

2012 Looking down line at 14 m.

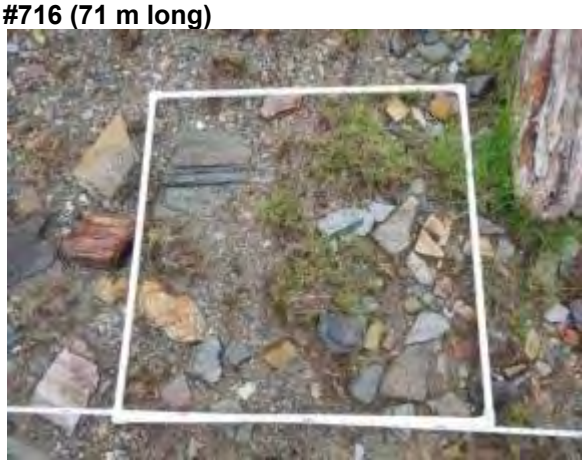
2015 Looking down line at 14 m.

2012 Looking up line at 14 m.

2015 Looking up line at 14 m.

Site 11 - Transect #716 (71 m long)

2012 Herb quadrat at 13 m.



2015 Herb quadrat at 13 m.

2012 Looking up line at 14 m.

2015 Looking up line at 14 m.

2012 Looking down line at 27 m.

2015 Looking down line at 27 m.

Site 12 was located on the west side of Duncan Reservoir, immediately south of La Barie Creek and was accessible only by boat. La Barie Creek runs through the north end of the site and had no influence on either transect (#5 or #718). See Table 3-12 for cover and species richness summaries.

Table 3-12: The dominant species, cumulative cover, species richness, and overall reservoir totals for Site 12 in 2015.

Dominant Species for Site 12	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_Care_utr (N)	67.6	52.5	0.6	h_W_Equi_arv (N)	3,443.7
h_Coll_lin (N)	32.5	25.3	0.3	h_W_Poly_lap (N)	943.4
h_W_Poly_lap (N)	22.9	17.8	0.2	g_Cinn_lat (N)	770.6
				h_Care_utr (N)	703.4
				g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness	Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.
	09	12	15		
Herb	20	17	8	52	
Shrub	4	0	0	13	
Tree	5	3	0	8	
Total	29	20	8	73	

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

The following summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 12. No change noted except for growth of trees and shrubs. Upland transect line lengths were: #718 – 0-7 m and #5 – 0-12 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Tsug_het Thuj_pli	100.0 97.5	39.6 38.6	14.8 5.7	T = 4
S 8 m^2	Shep_can	15.0	66.4	5.9	S = 5
H 1 m^2	Vacc_mem	15.0	98.7	100.0	H = 3
Upland Species for Reservoir = 76 - Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 12 had two transects lines: Transect #5 and Transect #718.

Site 12 - Transect #5 (60 m long)

2012 Herb quadrat at 44 m.

2015 Herb quadrat at 44 m.

2012 Looking down line at 32 m.

2015 Looking down line at 32 m.

2012 Looking down reservoir at 32 m.

2015 Looking down reservoir at 32 m.

Site 12 - Transect #718 (52 m long)

2012 Looking down line at 1 m.

2015 Looking down line at 1 m.

2012 Looking up reservoir at 10 m.

2015 Looking up reservoir at 10 m.

2012 Looking down reservoir at 10 m.

2015 Looking down reservoir at 10 m.

Site 13 was located on the west side of Duncan Reservoir at the extreme north end, at the confluence of Puddingbowl Creek and the reservoir. The site was accessed by foot via a small maintained path, which is used to access camp sites situated in the upland. Puddingbowl Creek intersected the site and was noted as an influence on all transects, since its channel was extremely braided and variable (Figure 3-1). Site 13 did not have the 10 m change in elevation surveyed due to the gradual sloping ground, which would have resulted in transect lines in excess of 1 km long. The full-pool edge scour that was easily identified for all previous sites was difficult to determine where transect lines should start in 2009. During our second visit (2012) it was determined that transect lines 4, 717, and 719 started above full-pool. Reed-canary grass occurred within one quadrat with a 2.5 per cent cover. No reed-canary grass was recorded in 2015 along any of the transect lines. See Table 3-13 for cover and species richness summaries.

Table 3-13: The dominant species, cumulative cover, species richness, and overall reservoir totals for Site 13 in 2015.

Dominant Species for Site 13	Cumulative Cover	Site Cover %	Reservoir cover %	Reservoir Dominant Species	Cumulative Cover
h_W_Equi_arv (N)	1752.7	57	15.8	h_W_Equi_arv (N)	3443.7
h_Care_las (N)	280.3	9.1	2.5	h_W_Poly_lap (N)	943.4
g_Cinn_lat (N)	170.7	5.6	1.5	g_Cinn_lat (N)	770.6
s_Sali_beb (N)	152.5	5.0	1.4	h_Care_utr (N)	703.4
				g_Aira.car (E)	530.2

Vegetation Type	Site Richness			Reservoir Richness
	09	12	15	
Herb	20	17	15	52
Shrub	4	0	6	13
Tree	5	3	2	8
Total	29	20	23	73

Coding: h = herb, g = grass, W = weed, s = shrub, t = tree, (N) = native, (E) = exotic. All species names are located in Appendix 1 and species codes are the first 4 letters of the genus and first 3 letters of species.

Note: Species Richness is the number of species recorded for the vegetation type and is provided by site and for the reservoir overall.

This summary is for the upland vegetation above full-pool that occurs within a two metre change in elevation above full-pool for Site 13. Transect Line 719 had numerous dead tree stems in the upland in 2012. All were absent in 2015 including the almost dead tree the tag was put on in 2009 which was dead in 2012. The first five metres up the transect line had considerably reduced cover compare to 2012. Within the tree plot there was an 85 per cent reduction in willow with cottonwood remaining the same at 2.5 per cent cover. Shrub plot had 94 per cent reduction in willow. Herb plot had no spruce or cottonwood seedlings recorded in 2012 and had 2.5 per cent cover by horsetail. Herb plot had 97.5 per cent bare ground and or woody debris. No change noted except for growth of trees and shrubs for the remaining transect lines. Upland transect line lengths were: #717 – 0-13 m, #719 – 0-20 m, #720 – 0-11 m, and #4 – 0-13 m.

Quadrat Area	Dominant Spp. for Site	Cumulative Cover (%)	Represents % Cov. of Site	Site Cov.by Res.Cov. (%)	Species Richness (#)
T 50 m^2	Sali Spp.	300	36.4	94.5	T = 9
S 8 m^2	Sali Spp. Oplo_hor	72.5 37.5	50.0 25.8	90.6 93.8	S = 7
H 1 m^2	Equi_syl Pleu_sch	37.5 37.5	40.5 40.5	100.0 27.8	H = 9
Upland Species for Reservoir = 76 - Tree = 11 Shrub = 26 Herb = 39					

Note: Species richness column is the species found within each quadrat size sampling unit on each site.

Site 13 had four transect lines: Transect #717, Transect #719, Transect #720, and Transect #4.

Site 13 - Transect #717 (100 m long)

2012 Herb quadrat at 40 m.

2015 Herb quadrat at 40 m.

2012 Looking up line at 54 m.

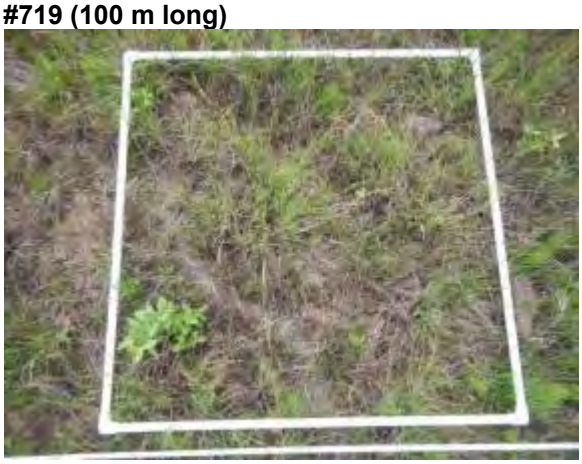
2015 Looking up line at 54 m.

2012 Looking down line at 54 m.

2015 Looking down line at 54 m.

Site 13 - Transect #719 (100 m long)

2012 Herb quadrat at 35 m.



2015 Herb quadrat at 35 m.

2012 Looking down line at 56 m.

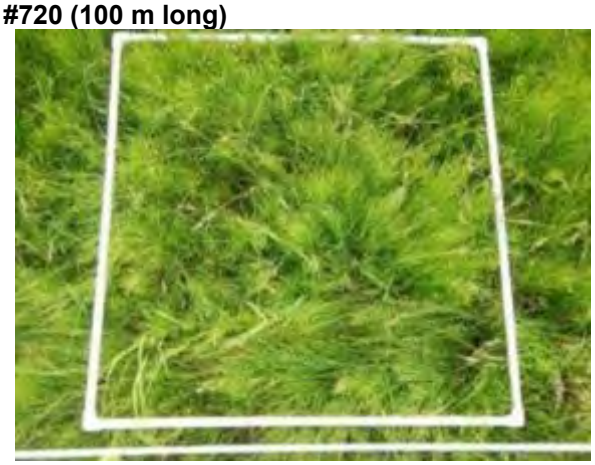
2015 Looking down line at 56 m.

2012 Looking up line at 56 m.

2015 Looking up line at 56 m.

Site 13 - Transect #720 (100 m long)

2012 Herb quadrat at 54 m.



2015 Herb quadrat at 54 m.

2012 Looking down line at 34 m.

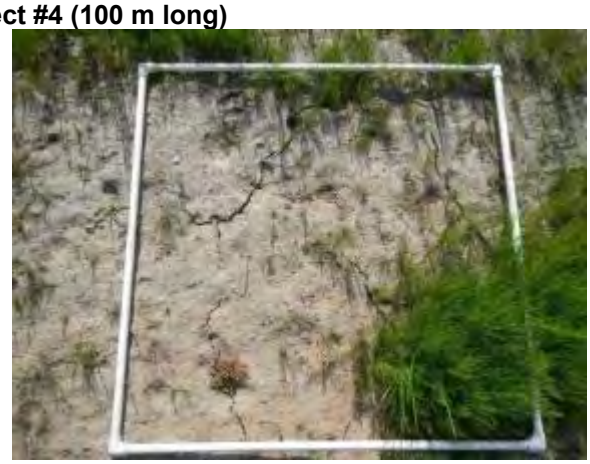
2015 Looking down line at 34 m.

2012 Looking down reservoir at 34 m.

2015 Looking down reservoir at 34 m.

Site 13 - Transect #4 (100 m long)

2012 Herb quadrat at 40 m.



2015 Herb quadrat at 40 m.

2012 Looking down line at 24 m.

2015 Looking down line at 24 m.

2012 Looking down reservoir at 41 m.

2015 Looking down reservoir at 41 m.

3.4 Vegetation Summary for Transect lines

Two integrative measures were used to address the two study hypotheses, these were total vegetation cover and species richness (number of species). Three main factors were identified that affected the integrative measures were: site, elevation, and substrate. Woody debris at the first metre change in elevation from full-pool was also noted in the field as a possible factor impacting shrub and tree recruitment following the full-pool overflow event in 2012. Subsequently, bare ground was assessed by elevation and site for the bare ground categories: wood, soil, mud, rock, and water.

Mean vegetation cover significantly decreased in 2015 compared to 2012 and 2009 (Figure 3-9) ($P < 0.00$, $W = 23610.0$ N = 627). The vegetation sampled within the 'Herb' quadrat followed a similar pattern of decreased cover since 2012 but with an increase in cover in 2012 compared to 2009. 'Shrub' quadrats had the highest mean cover in 2009 with a steady decline by 2015. The 'Tree' quadrat is reversed from the 'Shrub' quadrat sampling, with 2009 cover the lowest and 2015 the highest. The subsampling data in the field supports the air photo analyses for the total site areas.

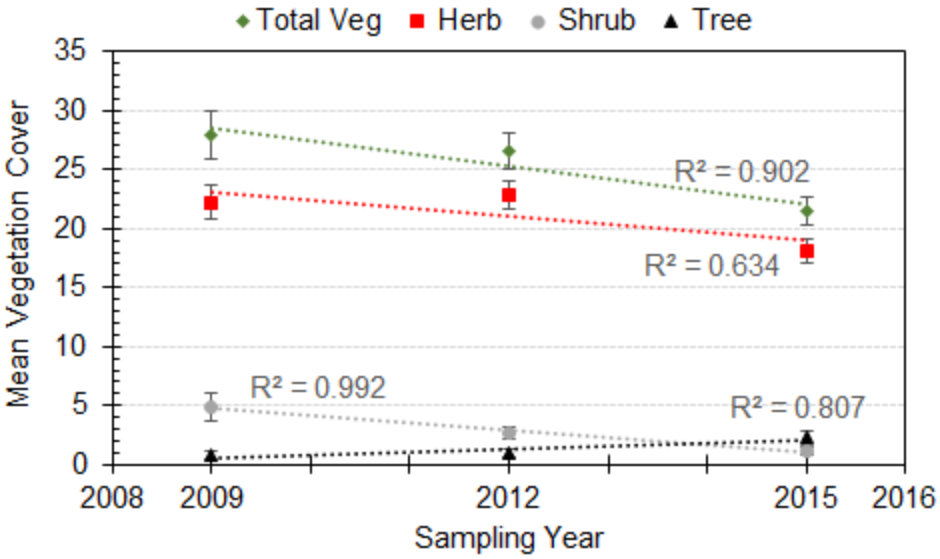


Figure 3-9: Mean (± s.e.) total vegetation cover, Herb quadrat cover, Shrub quadrat cover, and Tree quadrat cover for the reservoir, measured at the transect level. Trendline R^2 data is marked corresponding to each vegetation type from 2009 to 2015.

3.4.1 Elevation

Vegetation Cover

Increased vegetation cover was noted with progress up the transect elevations to 576.7 m. Per cent cover was highest in 2009 at the -1 m bracket (576.7 m to 575.7 m (-1)) compared to 2012 and 2015 with a gradual decrease in cover between years (Figure 3-10). All sampling years show a gradual decrease in cover from full-pool down to -8 m into the drawdown zone, with similar trend lines across the years.

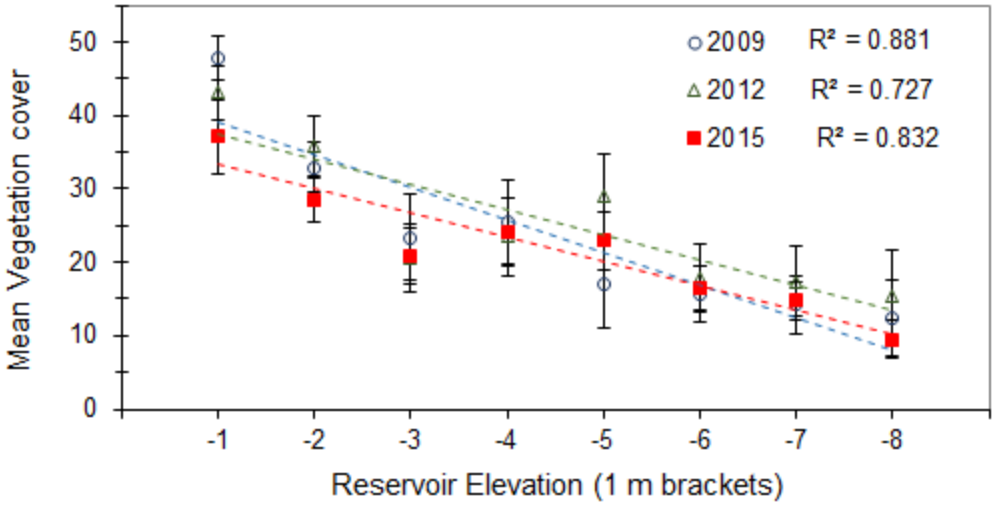


Figure 3-10: Mean (±s.e.) vegetation per cent (cumulative) *versus* elevation for quadrat data grouped in 1 m elevational intervals for 2009, 2012 and 2015. Trendlines correspond with marker colour.

The 85th percentile was 576.0 m, with 0.68 m change in elevation from full-pool being exposed for 85 to 100 per cent of the growing season. Therefore, the first -1 m change in elevation is greater than the 85th percentile range that is exposed. This elevation band is where the majority of the shrub and tree species occurred. There were some woody species occurring at low density cover in the -2 m elevation band at the herb and shrub size quadrats, but no trees (> 2.0 m tall) (Figure 3-11). When woody species occurred in the -2 m band, they generally occurred at the upper end of the metre band in elevation. Woody species that were less than or equal to 0.5 m tall were assessed in the herb quadrats but separated out for this analysis, in order to investigate the level of inundation that limits woody species recruitment and survival. No woody species were recorded in the -3 m bracket or lower in the drawdown zone. Both grass and herbaceous species had slightly lower vegetation cover at the -1 m elevation drop as compared to the -2 m band.

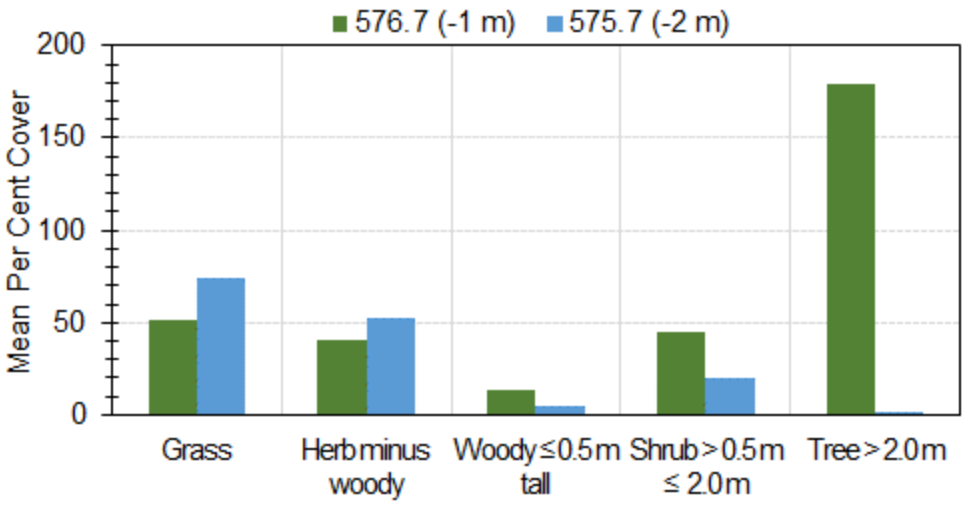


Figure 3-11: Mean per cent cover of herbaceous plants, grasses, shrubs, and trees from full-pool down 2 m decrease in elevation for 2015. Grass, herb, and seedlings or small saplings of woody species (≤ 0.5 m tall) were sampled in a 1 m² quadrat, shrubs in an 8 m² quadrat, and trees were sampled in 50 m² quadrat.

The same trend occurred in previous sampling years with decreases in herbaceous cover at the -1 m band compared to the -2 m band but an increase in shrub and tree cover at the -1 m band (Figure 3-12). There was also a decrease in mean herb cover at the -1 m band compared to 2012 and a decrease for shrub cover since 2009 but an increase in tree cover compared to previous years. Tree cover that occurred within the -1m band (576.7 m to 575.7 m) had trees occurring within a 0.5 m drop in elevation (576.7 m to 576.2 m) which is within the 85th percentile of the reservoir elevation.

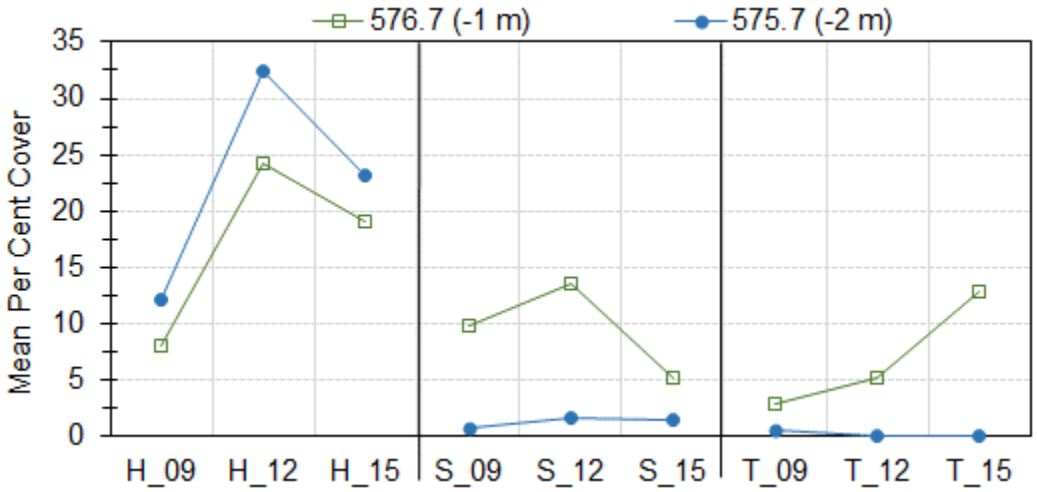


Figure 3-12: Mean per cent cover for Herb (H) quadrats (1 m²), Shrub (S) quadrats (8 m²), and Tree (T) quadrats (50 m²) for the three sampling years for 2 m change in elevation brackets from full-pool.

The five dominant species for the reservoir were identified in 2015 (Table 3-14). Cumulative cover for each species was included in the summary tables for each site in section 3.2 (see Table 3-2 to Table 3-13). The five species were selected for the highest cumulative vegetation cover and high distribution within the reservoir. The dominant

species in 2009 were similar but ranked in a different order. The large difference in cover between the 5th and the 6th ranking species resulted in only the top five being used in 2009 and 2015.

Table 3-14: The dominant species cover rank for 2009, 2012, and 2015. Perennials (P) and annuals (A) are indicated.

Species (Common Name)	Scientific Name	2009	2012	2015
Common Horsetail (P)	*Equisetum arvense*	1	1	1
Green Smartweed (A)	*Polygonum lapathifolium*	5	3	2
Nodding Wood-reed (P)	*Cinna latifolia*	4	2	3
Beaked Sedge (P)	*Carex utriculata*	2	5	4
Silvery Hairgrass (A)	*Aira caryophyllea*	3		5
Mouse-eared Chickweed (A)	*Cerastium vulgatum*		4	
Wormseed Mustard (A)	*Erysimum cheiranthoides*		6	

Common horse tail (*Equisetum arvense),* was the number one dominant species and it has been since 2009. Beaked sedge *(Carex utriculata)* was the second most abundant species in 2009 and fifth in 2012. In 2015 beaked sedge was ranked fourth for cover along transect lines. The annual, green smartweed (*Polygonum lapathifolium*) and perennial nodding wood-reed *(Cinna latifolia)* were second and third for dominance in 2015. The annual silvery hairgrass (*Aira caryophyllea)* was ranked fifth for dominant cover. There was a shift in dominant species in 2015 back to the five species in 2009 although the ranking order was different (see Table 3-14).

The annual species (green smartweed, and silvery hairgrass) and the first year seedlings of the perennial species (not sedges) dominated the lower elevation positions. Cover by these species was greatly reduced at higher elevation bands and almost absent from the -1 to -3 m bands (Figure 3-13).

For the five dominant species, it appears that perennials decrease as elevation decreases from full-pool while the two annual species have a reverse gradient with cover decreasing as elevation increases toward full-pool. Figure 3-13 shows these species listed in their ranked order from highest to lowest *versus* the elevation gradient. Common horsetail and nodding wood-reed perennial species were found as first year seedlings below the two metre change in elevation. Above the two metre change in elevation they were in mixtures of perennial and first year seedling growths depending on the site where they occurred.

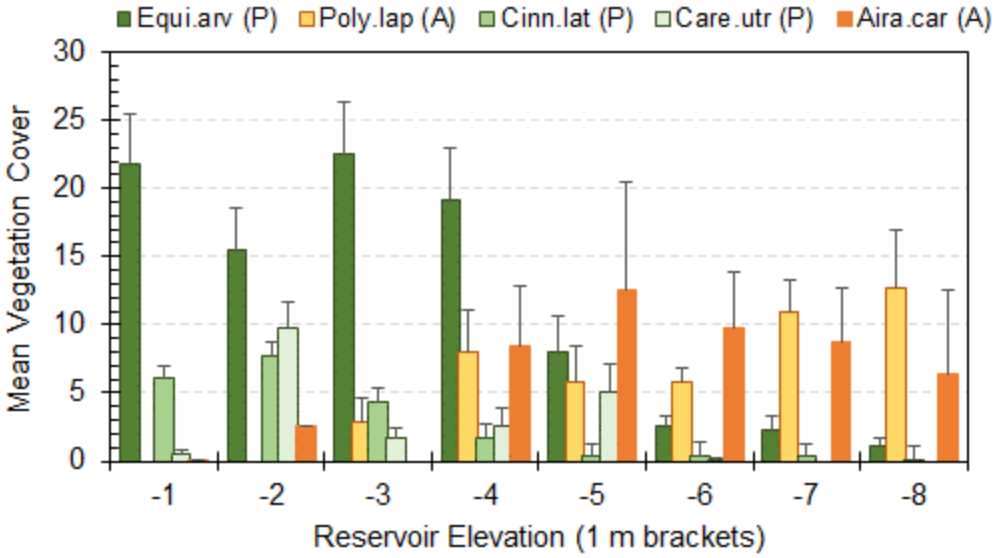


Figure 3-13: Mean (+ s.e.) per cent cover for the five dominant plant species *versus* elevation brackets within the drawdown zone of Duncan Reservoir in 2015.

When all of the annual species are plotted next to the perennials, a clear trend emerges similar to the findings in 2012. Annual species dominated the lower elevations of the drawdown zone and perennials were predominant in the upper elevations (Figure 3-14).

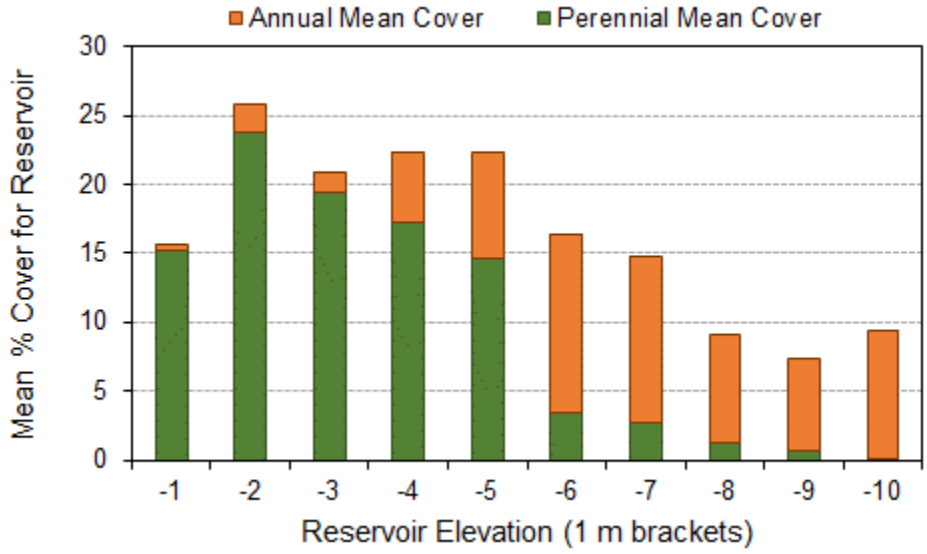


Figure 3-14: The mean per cent cover for annual and perennial plants and the elevation brackets at which they occurred within the Duncan Reservoir drawdown zone in 2015.

Species Richness

There were 73 species recorded within the reservoir drawdown zone for the 12 sites sampled. These species were split into three categories:

- 52 herbs made up of forbs, graminoids, mosses, and ferns and grouped as 'Herb';
- 13 species of shrubs; and
- 8 species of trees.

The complete list of species common and scientific names as well as codes (first 4 letters of genus and first 3 letters of species) is located in Appendix 1.

Species richness also followed an elevation gradient from high (60 species) within the first metre of full-pool elevation (576.7 m) to low (12 species for brackets -7 m, -9 m, and -10 m) (Figure 3-15). The top metre bracket (-1 m) is the band where the majority of the tree and shrub species occurred. Comparison between 2009, 2012, and 2015 showed a similar pattern.

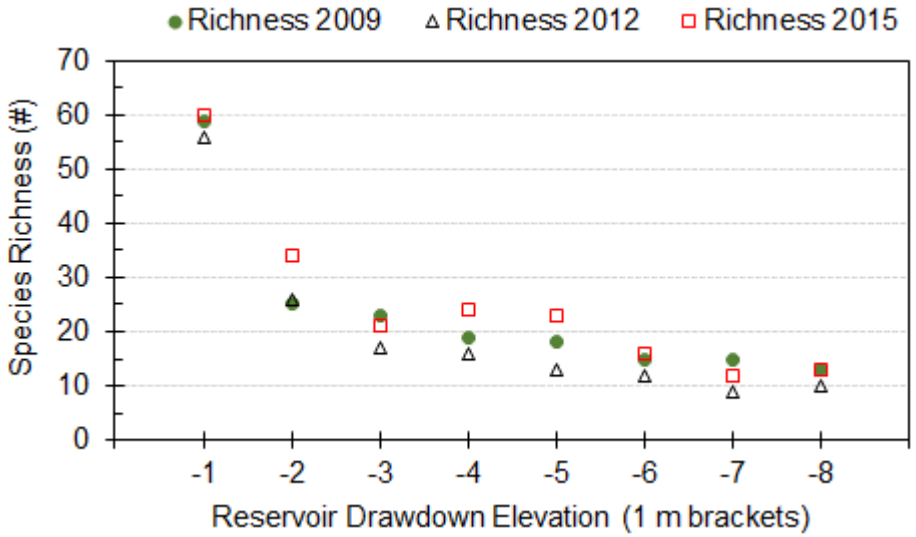


Figure 3-15: Plant species richness *versus* elevation in the Duncan Reservoir drawdown zone in 2009, 2012, and 2015. Reservoir elevations are in one meter increments, starting at full-pool (0 to -1 m bracket) and dropping to -8 m (-7 m to -8 m) below full-pool.

Integrative Measure of Plant Species Diversity

The Shannon-Wiener (H') or "Shannon" index was calculated in 2015 to provide a measure of plant biodiversity. This index varied across the elevations, with the lowest at the elevation bracket -8 m in the drawdown zone (Figure 3-16). The highest H values were observed for elevation bracket -1 m (0.63) with higher diversity for 2015 compared to 2012. The lowest H value for 2015 was 0.31 for elevation bracket -8 m.

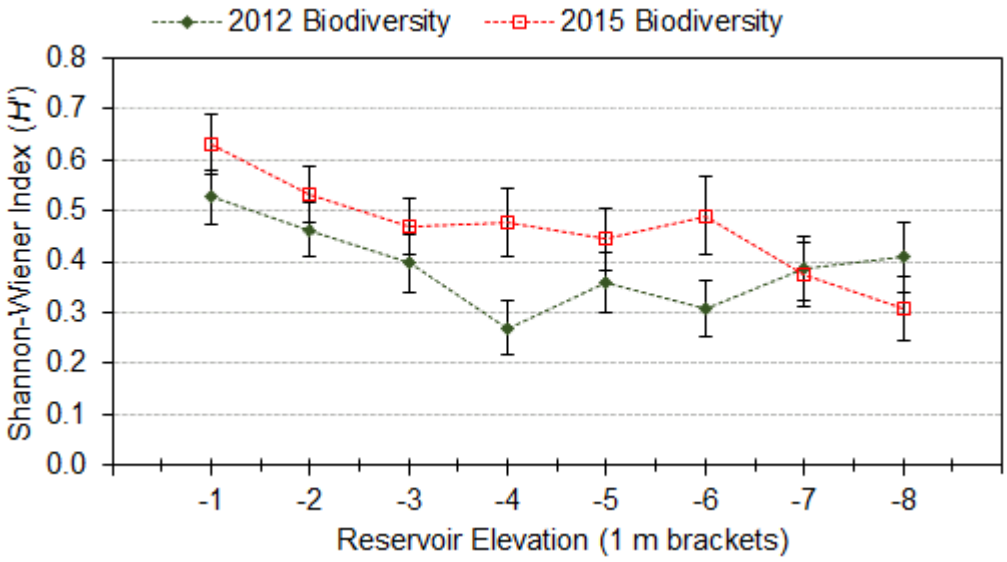


Figure 3-16: Mean (± s.e.) vegetation diversity (Shannon-Wiener diversity (*H'*)) *versus* 1 m elevation brackets for 2012 and 2015.

Bare Ground

Bare ground was broken into five categories: wood, soil, mud, rock, and water. Litter cover was assessed but not included in bare ground totals. Woody debris (Wood) mainly occurred at the 1 m bracket below full-pool. Bare ground (Soil) had a steady increase in cover as elevation dropped in the drawdown zone (Figure 3-17). Litter was highest at the 1 m bracket with low levels at the 2 and 3 metre brackets and close to zero at the lower elevations.

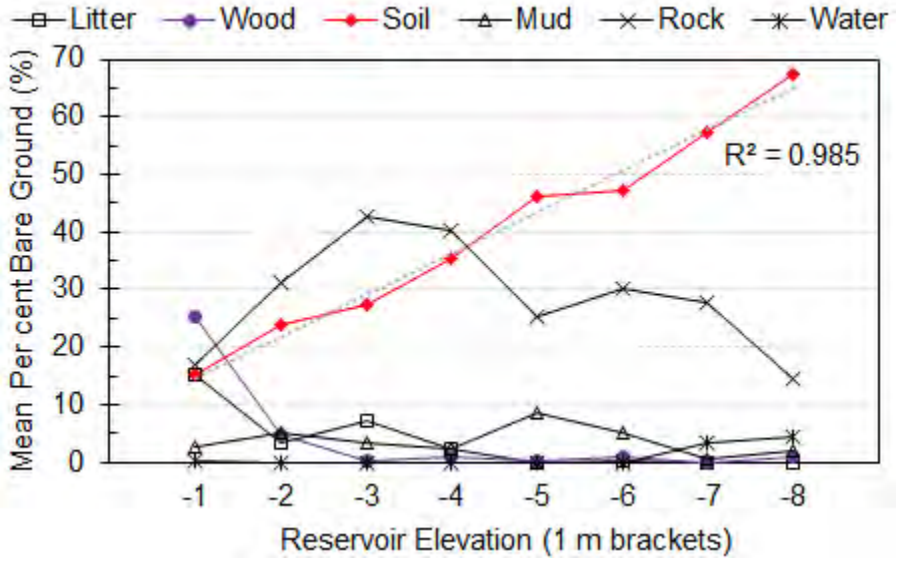


Figure 3-17: Mean bare ground and litter covers by elevation for all sites combined.

3.4.2 Site

Vegetation Cover

The mean cover per site showed similar variation in 2015 as compared to 2012. Sites 1, 5, 6, 7, 9, 11, and 13 were similar in both years. There was an apparent decrease in cover for Sites 2, 3, 4, 10, and 12 (Figure 3-18). Sites 2, 4, and 12 had significant decreases (Table 3-15). Site 13 does not have the full range in elevation cover data and was not compared to the rest of the sites for position along the reservoir.

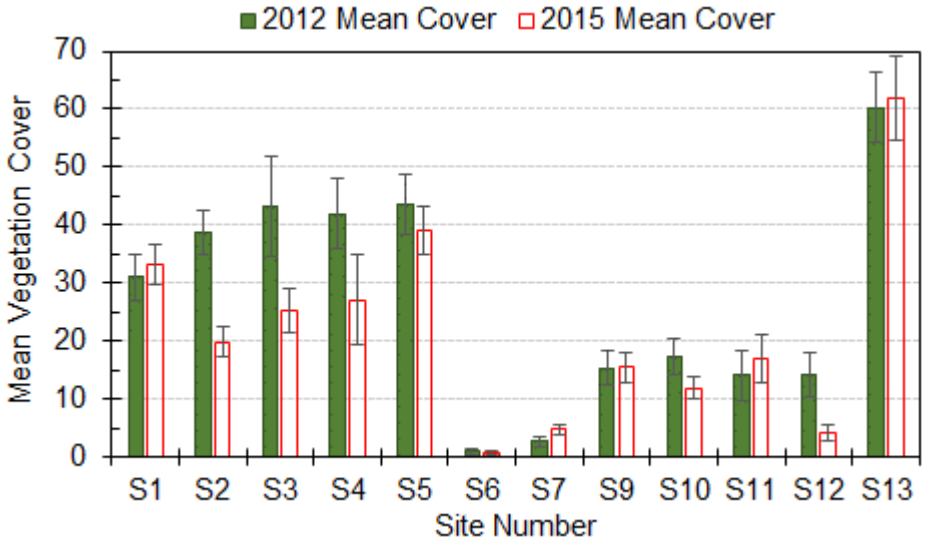


Figure 3-18: Total mean (± s.e.) vegetation cover for each site for 2012 and 2015.

Table 3-15: Significant statistical results for paired t-test and Wilcoxon Signed Rank tests when data did not pass normality test.

Site	P value	*t*	*W*	*df*	N
S2	<0.001		-179.0		84
S4	0.04	2.2		26	27
S12	0.002		-384.0		45

Species Diversity

Species diversity varied across sites with the southern end of the reservoir (Sites 1 to 5) having higher diversity than the middle and northern sites (Figure 3-19). There was a slightly higher diversity for 2015 compared to 2012. Exceptions were Site 11 and 12. Site 1 had the largest increase compared to 2012. Diversity ranged from 1.0 for Site 1 to 0.03 for Site 6. Diversity for 2009 was not directly compared because of difference in the length of transect lines and number of transect lines per site. The reduced data set for 2012 was matched and directly compared to the 2009 data in Polzin and Rood 2013.

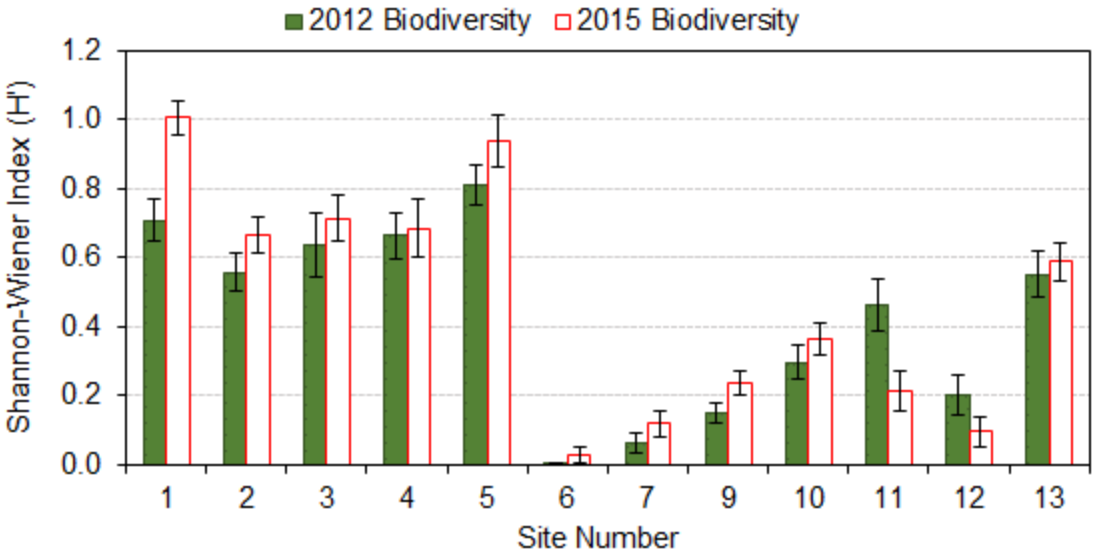


Figure 3-19: Mean (± s.e.) Shannon-Wiener indices of diversity (*H'*) by site for 2012 and 2015.

Bare Ground

Bare ground averaged for each site illustrates the differences across sites (Figure 3-20). The 'Water' category included flowing and pooled water that occurred along transect lines during sampling, and was recorded for four of the twelve sites. Sites 5 and 11 averaged just under 10 per cent while Sites 4 and 13 only had a trace amount of water along transect lines. Mud was recorded only at Site 10. Sites 6 and 12 have the highest percentage of bare ground recorded by site.

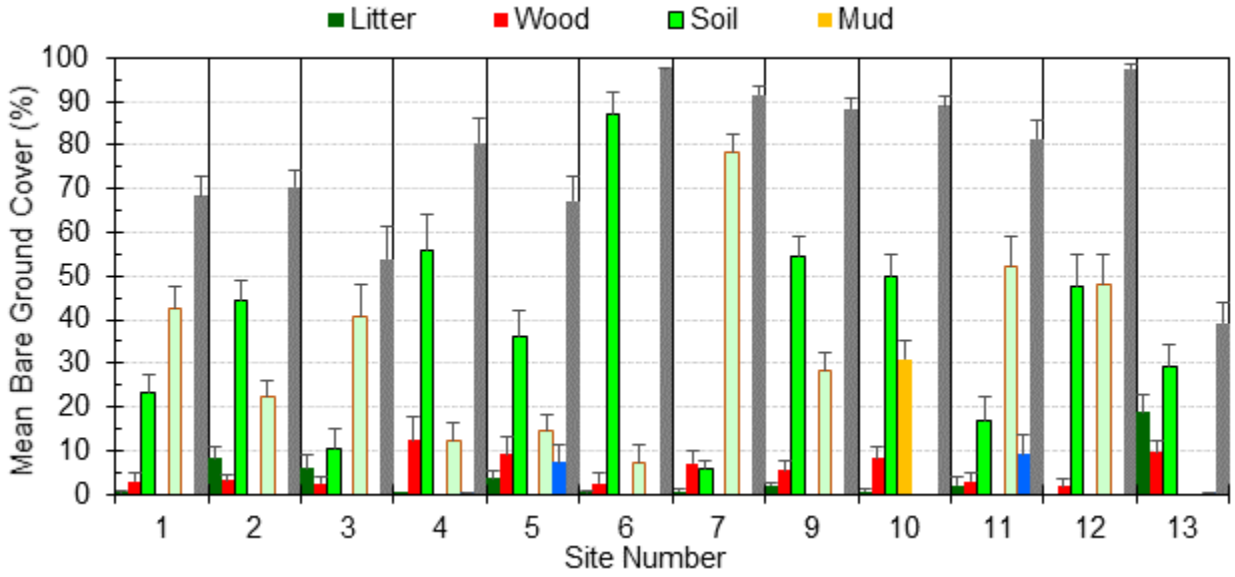


Figure 3-20: Mean (+ s.e.) bare ground and litter covers by sites.

3.4.3 Substrate Texture

The Substrate texture index (1 = silt, very fine to 5 = bolder, very coarse) showed a steady increase of particle size with decreasing elevation similar to previous surveys (Figure 3-21). The trend was apparently slightly stronger in 2012, with 2015 showing a similar trend level as 2009. There was limited variation (0.03 to 0.08 s.e.) for the elevation brackets.

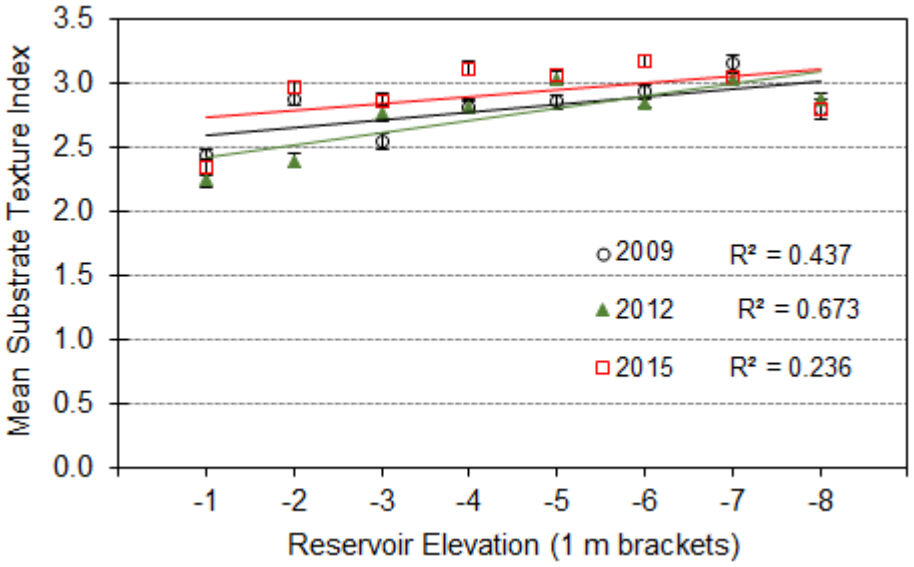


Figure 3-21: Mean (± s.e.) substrate texture index *versus* elevation grouped into 1 m elevational intervals for 2009, 12, and 15. Substrate texture index (1 = silt (very fine) to 5 = bolder (very coarse)).

The substrate texture index showed similar results to the 2012 data for most sites (Figure 3-22). Site 3 provided the exception with apparently finer texture.

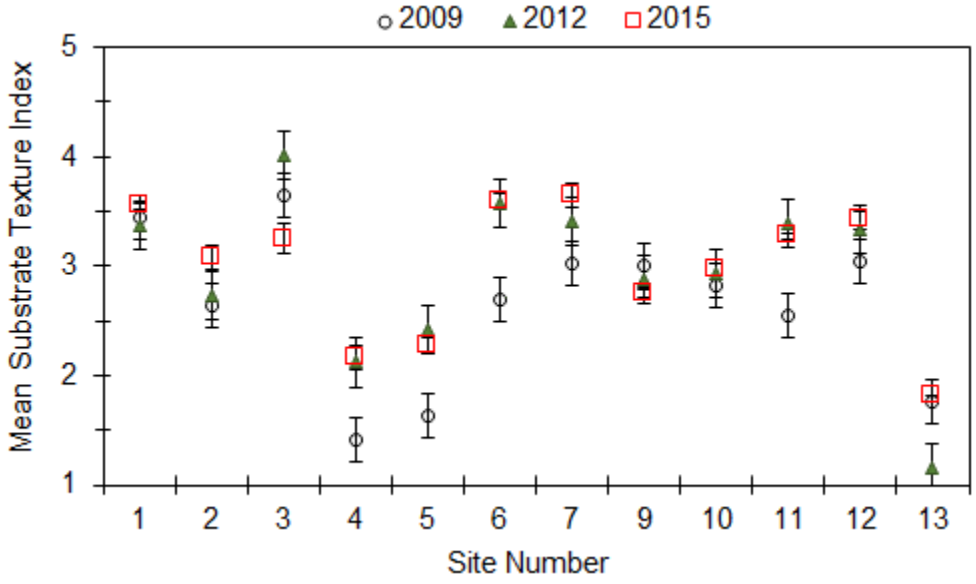


Figure 3-22: Mean (± s.e.) substrate texture index for each site for 2009, 2012, and 2015.

In 2015, the vegetation cover was correlated with the substrate texture index across the quadrats (Figure 3-23A P <0.00, R^2 =0.14). As substrate increased in coarseness, vegetation cover generally decreased, but with a wide range of variation. Species diversity did not show as clear of a response but had a significant correlation (P < 0.01, R^2 = 0.04) (Figure 3-23B). As substrate texture increases species diversity declines, similar to 2012 results.

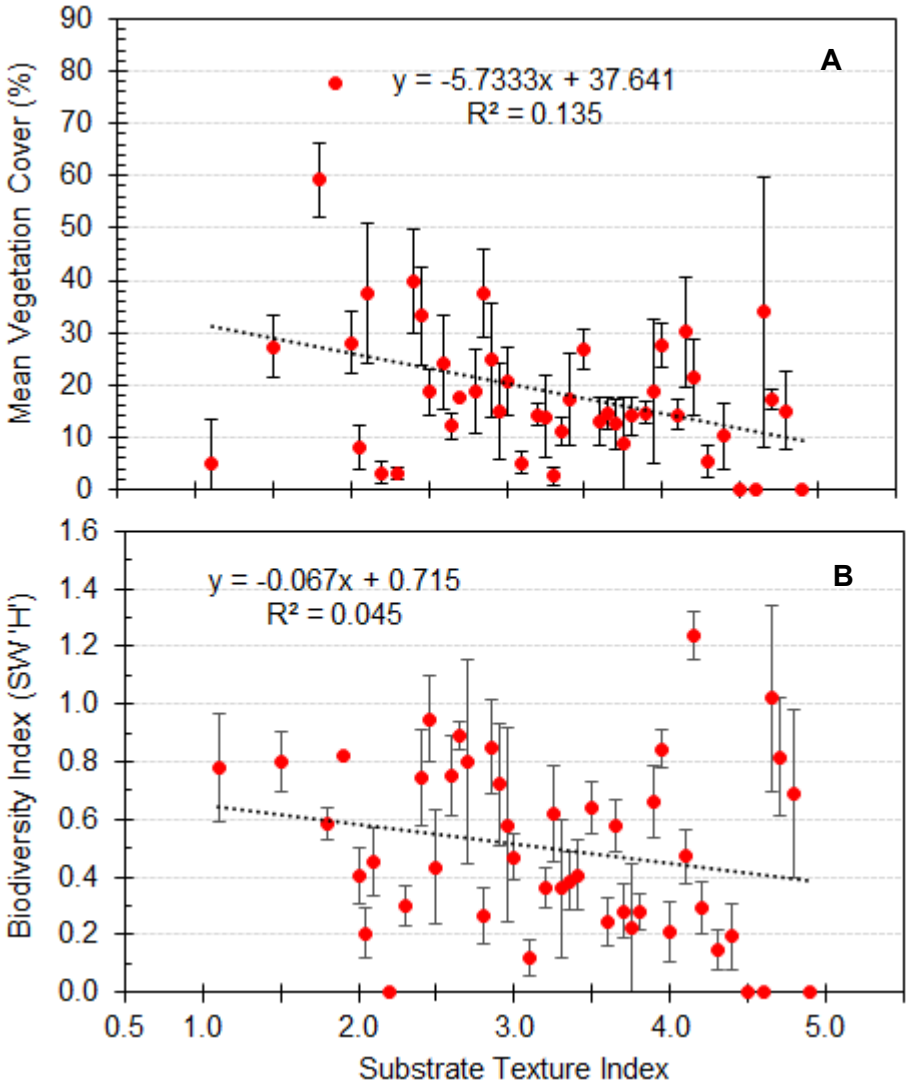


Figure 3-23: Mean (± s.e.) vegetation cover (A) species diversity (B) *versus* the substrate texture index for all sites in the drawdown zone of Duncan reservoir.

4.0 DISCUSSION

The DDMMON#8-2 study is designed to monitor the changes in area of vegetation communities within 8 m below full pool in years 1 (baseline data), 4, 7, and 10 of the monitoring period. Monitoring will enable tracking potential changes within the riparian vegetation community in the drawdown zone of the Duncan Reservoir that may occur under the implementation of operating Alternative S73 (Alt S73). The two null hypotheses to be tested in 2018 (Year 10 which is study Year 4) for this monitoring program are:

- H_{01}: Alt S73 will not result in decreases to the area and alterations in the species composition of both wetland and riparian vegetation communities; and
- H_{02}: Reservoir elevations do not affect riparian distribution and abundance through the duration and frequency of root- and shoot-zone flooding.

These hypotheses will be formally tested following data collection of study Year 4 (10th year of study). In this study Year 3 report (year 7 after the flow alteration), we present the data collected and provide summaries of the subsequent patterns. We continued to consider the physical environmental factors that were identified in 2009 as being associated with the occurrence and abundances of the different plant species and communities.

The Duncan Reservoir Study Year 3 investigated the draw-down zone from full-pool (576.7 m) down to 10 m below full-pool (566.7 m) and to 8 m below full-pool for high riparian potential sites. The two main objectives for 2015 monitoring year were:

1. Map the distribution of wetland and riparian vegetation within the drawdown zone of Duncan Reservoir using aerial photography; and
2. Monitor changes over time in the area coverage and plant species composition of vegetated communities within the drawdown zone of Duncan Reservoir under operating regime Alt S73.

4.1 Weather

The 2015 sampling year occurred during an early spring, with high temperatures during June. This was very different from 2012 which had an extremely wet June but average spring temperatures. The 2009 sampling year commenced with a very late start and cool spring for the area. Three different spring weather patterns makes it difficult to assess vegetation changes that are influenced by weather that interacts with the rise and fall of reservoir water levels. It appears that changes in plant communities' dominant species, especially annual species, may be due to the different weather patterns across the sampling years. Precipitation levels seem to influence vegetation cover more than temperature for the herbaceous species as the 2012 results showed. Some drought stress and mortality was noted for the first time during the field work in 2015 but it was very site and elevation specific.

4.2 Vegetation Mapping

Vegetation mapping in 2015 involved change-detection from the 2012 and 2009 distributions. Change was apparent across the three sampling years but was only slightly different in 2012 compared to 2009. In 2015 the change was greater, with substantial increase in bare ground area (ha) (56.4 per cent) compared to 2009 (15.3 per cent). Vegetated ground area significantly decreased in 2015 (43.5 per cent) compared to 2009 area (84.7 per cent) (Figure 3-2). As bare ground increased in area, vegetated ground area similarly decreased (Appendix 4).

Vegetation cover was split into three types, H (herbaceous), SH (shrub), and TR (tree), with community types for each vegetation polygon identified by the dominant species for the community. A new community type, H16 (silvery hair-grass) was created because it dominated Site 4 and Site 5. Silvery hair-grass occurred at many sites since 2009 but it was never the dominant species for a community and was previously grouped into H4 (grass) since there were a number of different dominant species for some small areas. In 2015 there were large areas with this grass species dominant so a new class was added.

This may be an indication of the influence of the annual weather pattern on community types since silvery hair-grass occurs on moderately to very dry, nutrient poor soils and is an exotic annual (Stewart and Hebda 2000). Because it had been present at the reservoir sites since 2009, it was able to expand in suitable habitats during the hot dry spring of 2015.

Some of the increase in bare ground can be attributed to the 2015 early spring weather conditions and the unusually hot June temperatures. Some quadrats had dead vegetation, which had sprouted earlier in the spring but the above ground growth was dead by June monitoring. This was especially common for horsetail at some sites. Site 1 was visited in early May (which was not part of the monitoring program, M.L. Polzin, May 4, 2015) and extensive vegetation cover was observed in the drawdown zone. This was noticeably reduced when the June monitoring occurred at the site.

The dominant community for the reservoir was H1, with the perennial common horsetail. This remained at a generally similar area of cover since 2009, with a slight decreasing trend to 2015. When horsetail occurred at lower elevations it was first year seedlings, as compared to plants in the -1 m to -2 m bracket elevations that were a mix of seedlings and perennial growth forms. Some of the decrease may have been due to the hot weather in June, which resulted in desiccation of plants in some areas.

The other two important perennial communities H2 (sedge) and H6 (bulrush) experienced changes in area particularly at two Sites. Community H2 occurred at Sites 2 and 9 and showed a decline since 2009 from 1.4 ha to 0.32 ha. Beaked sedge area has decreased especially where the areas are at and below the -3 m elevation bracket. Soil has eroded away from the sedge clumps so much of the root ball was sitting above ground (Figure 4-1).

Figure 4-1: Sedge clumps looking up reservoir from Site 9, Transect 709 (A) (-2 m elevation bracket) and a close up of a sedge and grass clump (B) (-1 m elevation bracket).

There were no new seedlings noted along transect lines or while traversing Sites 2 and 9 for ground truthing, and only perennial clumps occurred. The only site with seedlings was Site 13 (no H2 community type), where sedges were growing from substrate with no exposed and elevated root mass and mixed with horsetail in the H1 community type. There were dead clumps in the H2 community in 2015 which were not noted in 2012 or 2009. Inundation duration appears to be impacting sedge communities with slight reduction from the drought in 2015 and the majority of the reduction from inundation duration and/or scouring of clumps while inundated.

The scoured clumps may float to other areas where they resettle once water levels drop. One indication that this may happen was the absence of dead clumps in the areas where reduction has occurred. Whether they continue to grow while they are floating and re-establish once the water levels recede is a possible explanation but not an observed process for the Duncan Reservoir. This scour and floating of riparian vegetation was noted on the Kinbasket Reservoir during field observation in 2008 by Mary Louise Polzin which occurred for sedge clumps as well as some very large wetland clumps that included multiple herbaceous species as well as willows and dogwoods with a substantial soil wade held by the roots of the plants. The Duncan Reservoir was not visited once it was filled so there is no documentation of sedge clumps actually floating near shore once it had reached full-pool.

The H6 small-flower bulrush (*Scirpus microcarpus*) community occurred at Sites 5 and 9 where there was an interesting fluctuation in total area between years. In 2012 there was an increase in area from 0.15 ha to 0.96 ha but subsequently a decrease back to levels in 2015 (0.14 ha) similar to 2009. This community occurred within the -1 m elevation bracket at both sites and did not show any erosion of sediment, with no exposed root balls like most of the sedge communities. The bulrush community at these sites appear to be linked to increased moisture such as with increased spring rain. They are also associated with a seepage relatively close to or running through the community unit. This spring-type seepage appeared to be higher in 2012, as compared to 2015 and 2009 further linking bulrush density and occurrence to increased moisture levels. Low density cover of sedges also occurred within the H6 community type which was apparently not scoured like the H2 community class was. The reduction in H6 area including the sedges within the community may have been due to the dryer, earlier, and warmer than the average spring.

The area exposed from 85 to 100 per cent of the time has significantly decreased for the three years tested (2009 = 575.0 m, 2011 = 575.5 m, 2014 = 576.0 m). Figure 3-5 shows the reservoir stage from July 1 to September 30, which shows the elevations that were never inundated and the fluctuations within each year. The peak fill levels and derations were:

- 2009 – 575.82^{+} m August 21 to August 23;
- 2011 – 576.72 m August 1 to August 3;
- 2012 – above full-pool 576.74 m July 21, 576.90 m July 23, 576.81 m July 24, and 576.68 m July 25 (full-pool). There was another increase in reservoir level August 7 to August 9 = 576.50 m;
- 2014 – 576.38 m August 2 to August 14, then increased to 576.51 m August 15 with steady decline to August 2 level by August 20 and then continues to decline; and
- 2015 – 574.94 m August 3, 574.99 m August 4, and 574.97 m August 5.

The exceptional year 2012 had approximately 0.3 m change in elevation below full pool free of inundation for most of the interval after July 31, 2012. The vegetation monitored in 2015 was particularly influenced by the 2014 pattern, with the band to 0. 3 m below full-pool exposed throughout that year.

The 2015 reservoir elevations were lower than the in prior study years with the highest fill stage reaching 574.9 m for four days, from August 3 to 6, with a gradual draw down following the peak. This resulted in 1.7 m of draw down elevation and greater area open for seedling recruitment without subsequent inundation during the growth season. Depending on the operating regime for 2016 to 2018, there could be increased perennial

vegetation, including woody species, colonizing the upper level of the draw down zone. This would particularly occur in areas with sparse woody debris, and could replace some of the vegetation losses resulting from the 2012 emergency operation of the reservoir levels.

Vegetation mapping in 2012 confirmed a very strong correspondence between vegetation cover and reservoir elevation. Elevation is also directly related to inundation interval, with lower zones being inundated for longer intervals. Subsequently, the length of inundation was associated with approximately 90 per cent of the variation in vegetation cover for the study sites in 2012 (aerial photograph analysis) (Polzin and Rood 2013) and was consistent with 2015 results. Because of the strong correspondence it was recommended that a non-scheduled field survey in 2013 be completed to monitor the -1 m elevation bracket from 575.7 m to 576.7 m, near the full-pool elevation. This would determine if any change followed from the elevated 2012 reservoir levels that were initiated to minimize flooding downstream of the dam. No field survey was undertaken and consequently the probable effect on vegetation cover from the 2012 fill regime can only be deduced. The strongest impact appears to be the loss of woody species recruitment in the first m drop in elevation from full-pool. This was attributed mainly to woody debris scour of established seedling and wood debris cover of open ground reducing seedling establishment area available for new recruitment. This provided a 66.3 per cent reduction from the 2012 cover, and there were also apparent reductions in herbaceous cover in the affected areas.

Young seedlings that were less than 50 cm tall in 2012 were not represented with larger seedlings or saplings with three years of growth to 2015. This suggests that they were scoured away and that there was no replacement recruitment by June 2015. It was likely that the increase in woody debris was responsible for the loss of those seedlings. The woody debris extended below full-pool at some sites and was increased in total area covered within the upper elevation draw down zone. Most of the seedlings that were lost were cottonwoods and willow species, and both can withstand extended inundation (Braatne et al. 1996, Braatne et al. 2003) but the scour from the moving woody debris could have broken or uprooted the seedlings. The dense woody debris at many sites also reduced the area of herbaceous cover and was typically associated with the bare ground cover type.

4.3 Vegetation Monitoring: Vegetation Cover, Species Richness, and Diversity

Field monitoring through the use of transect lines confirmed the results from the aerial photography analyses. Total vegetation cover for the study area declined since 2009 with variation occurring within the three sampling units. The Shrub cover only occurs from full-pool to 574.7 m (-1 m and -2 m elevation bracket) and it showed a steady decline since 2009 while the Tree cover (only at -1 m elevation bracket) had the reverse pattern with a steady increase since 2009. There was no significant difference between years, but a strong declining trend for total vegetation cover. Herb cover had a moderate declining trend since 2009. The Herb cover is more susceptible to spring weather conditions because of the annual growth forms that colonize the drawdown zone. The sampling year 2012 had above average precipitation that may have resulted in the higher herbaceous cover for the year compared to 2009 and 2015 and higher total cover since the herbaceous layer makes up the majority of the cover in the total cover unit. Precipitation levels in the spring appear to have more influence on herbaceous cover than temperature as 2009 was a cool late spring and 2015 was an early hot spring with similar precipitation levels for the two years which may have resulted in similar herbaceous cover levels and similar dominant species.

There were five dominant species identified for the reservoir (all sites) in 2015. They were the same species as identified in 2009 but ranked in a different order. The most notable change occurred for beaked sedge which was the second ranked dominant species in 2009 and moved to forth in 2015.

Elevation was one of the physical factors identified in 2009 and investigated in 2015. There was a general decline in vegetation cover with decreasing elevation from full-pool compared to 2012 and 2009. For the herbaceous cover, perennials continued to dominate the upper levels of the drawdown zone and annuals the lower levels similar to 2009 and 2012 results. The crossover between perennials and annuals occurred at the -6 m bracket. However, below the -3 m bracket the perennial species were mainly first year seedlings compared to the perennial growth form at the higher elevation where a mix of both growth forms occurred.

The increased loss of vegetation at the 'Herb' quadrat and especially at the 'Shrub' quadrat levels suggest something other than inundation duration was responsible for the decrease not explained by growth for the woody species. The fact that there was higher herbaceous cover at the -2 m bracket which reduces the probability that it was weather dependent, and both Herb and Shrub quadrats found a decrease at the -1 m bracket suggests that the increased deposition of woody debris within this zone may have been the factor responsible for some of the reduction in overall cover. The 2012 above full-pool fill and high pool stage may have reduced woody vegetation cover within this -1 m bracket. The dense woody debris cover may not have allowed colonization of woody species in subsequent years. It may be a combination of these two factors. Because of this, woody debris should be included as a factor when hypothesis testing occurs in 2018.

Species richness *versus* elevation showed similar results to previous years. The first -1 m bracket change in elevation from full-pool had the highest species richness similar to other years. There was some variation occurring at each elevation bracket. Species richness in 2015 was consistently higher than 2012. Elevation brackets were slightly higher or lower or similar to 2009 levels. The wet 2012 spring may have limited species richness slightly by excluding some species that preferred dryer condition.

Diversity was also higher versus elevation compared to 2012 except at the -7 m bracket where both years were similar and -8 m where 2015 diversity was lower than 2012. Lower elevations having lower diversity may have been due to one or two species dominating these elevations in 2015 where as there was more equal distribution of species in 2012. This may also be a result of the dry hot June in 2015.

Substrate texture index *versus* elevation was similar to 2009 substrate index and slightly higher on average than 2012. This may represent minor shifts in sediment deposition and erosion of fine sediment between years. This variation occurred between sites with some sites having decreases in substrate texture compared to 2012 and 2009 while other sites were similar to both previous years. Site 3 was the only site with decreased texture index compared to both 2009 and 2012. Site 3 had large outcrops of bedrock with low areas and large cracks in the bedrock filled with finer textured substrate. These areas may have experienced increased deposition of finer substrate in 2012 (reservoir stage above full-pool fill) lowering the mean substrate texture index for this site.

Vegetation cover, species richness and diversity at sites showed varying trends compared to 2009 and 2012 with a decline in cover and diversity since 2009. The 2015 data builds on the past two years of monitoring suggesting that H_{o2} may not be supported. Reservoir elevation, substrate texture, as well as site are affecting vegetation abundance (cover)

and species diversity levels. The addition of woody debris as a possible factor appears to be affecting cover within the first two metre drop in elevation from full-pool.

5.0 CONCLUSION

The vegetation in the Duncan Reservoir drawdown zone has generally declined since the first study year, 2009. There has been a decrease in vegetation cover and an increase in the area of bare ground as monitored by the interpretation of aerial photographs and with belt transect-based field assessments. There was a shift in community type with one new herbaceous community which was lumped in the generic grass class in 2012 and 2009, and one new small tree community. There were reductions of three herbaceous communities from 2009 and 2012 and the reduction of one herb class (H15), which was added in 2012 but did not occur in 2015.

The ground level monitoring confirmed the pattern, with vegetation cover decreasing since 2009. Species richness was similar between years and diversity apparently decreased since 2009. There were 73 species recorded in the study quadrats, with 52 herbaceous species including; graminoids, mosses, and ferns, 13 shrub species, and eight tree species. The five most abundant plant species were (sequentially):

1) *Equisetum arvense* (common horsetail);
2) *Polygonium lapathifolium* (green smartweed);
3) *Cinna latifolia* (nodding wood-reed)
4) *Carex utriculata* (beaked sedge); and
5) *Aira caryophyllea* (silvery hair-grass).

The total number of plant species in 2015 was the same as in 2009 and these were higher than in 2012. Many of the species occurring within the drawdown zone were annuals, including ruderal annuals which are typically weedy species with the capacity for prolific reproduction. *Centaurea maculsa* (spotted knapweed) was the only invasive, noxious, exotic species recorded in the study area in 2009, with total cumulative cover of 0.32 per cent cover for the reservoir draw down zone. This was reduced by 2015 to 0.21 per cent. Spotted knapweed occurred only at the highest elevation zone adjacent to full-pool. An apparent intolerance of inundation has kept this species from spreading within the drawdown zone and is reducing established cover area. Woody species in the Shrub sampling units decreased since 2009 while woody species in the Tree sampling units increased since 2009.

Elevation was a major environmental factor influencing vegetation cover and richness. Shrubs and trees were restricted to the upper-most band, 575.7 to 576.7 m elevation, and herbaceous perennials were also more common along the upper zones. In contrast, the annuals occurred over more extensive areas of the drawdown zone, and some species were most abundant at the lower elevation zones for this study (-10 m, the lowest field monitoring level). Annuals dominated the lower study drawdown zone from 566.7 m to 571.7 m elevation and perennials the upper drawdown zone from 571.7 to 576.7 m (full-pool). This differentiation was similar to patterns observed in 2009 and 2012.

There were significant differences among sites in vegetation cover in 2015 compared to 2012 with a decrease in vegetation cover occurring at Sites 2, 4, and 12. All other sites were similar or not significantly different. Plant species diversity was higher at the southern end of the reservoir compared to the northern end with Site 6 in the mid-reservoir zone having the lowest diversity and cover. This is consistent with 2009 and 2012 data.

The third most prominent environmental factor was substrate: vegetation cover and diversity increased on sites with finer texture substrate. There were differences in the substrate patterns across the plant species, with some species more and some less responsive to substrate texture.

Woody debris was investigated in 2015 year as a possible factor to consider during hypothesis testing. The impact from woody debris particularly occurs from full-pool to 575.7 m, a 1 m drop in elevation. This largely impacted woody species but these occurred at very low densities.

We cannot address the Management Question “Will the implementation of DDM WUP result in neutral, positive, or negative changes to riparian vegetation communities within the drawdown zone for the Duncan Reservoir” as the factors responsible for the decrease in vegetation cover will not be tested until 2018. It maybe that the decrease in vegetation cover is a combination of spring weather conditions, the implementation DDM WUP and other factors identified since 2009. Testing the hypotheses will result in the assessment of the percentage of change attributed to weather, other factors, and how much is attributed to the implementation of DDM WUP.

6.0 RECOMMENDATIONS

We suggest a second field visit within the next study year so that the full pool reservoir stage can be assessed at all of the sites. The second field assessment would occur when the reservoir reaches the fill level for that year, in late July or early August. We expect minimal differences in the dam stage versus full pool shoreline elevation at the sites on the southern end near the dam, but differences may increase for the northern sites, and especially Site 13. This knowledge would benefit the last year of data collection as the full-pool boundary could be mapped more accurately and elevation data adjusted to the actual shoreline stage for each site.

During the second field visit we would also investigate the occurrence and distribution of any floating riparian clumps of vegetation. This would help to determine the cause for the reduction of sedges at lower elevations, or alternately how sedges can persist at elevations with long inundation periods.

Woody debris management could reduce the scour and the cover of bare ground in the first two metres drop in elevation from full-pool. It could also create terrestrial habitat and fish habitat for juvenile fish when the reservoir is at full-pool. At sampling sites where there is extensive woody debris it could be gathered and piled (with or without anchorage to be determined before implementation) on the shore above full-pool with overhang of some logs into the drawdown zone. This would create habitat for small mammals, safe areas (safe from scour by floating woody debris) for woody vegetation to establish and thrive as well as opening up the -1 m to -2 m elevation band for vegetation recruitment including woody species while providing fish habitat for young fish to hide and feed and removing woody debris from the reservoir. At Site 10, the extensive woody debris recorded in 2009 was mechanically gathered burned and buried (based on assumption of the disturbance noted in 2012 may not be exactly what occurred on site) which reduced vegetation cover at this site in 2012 and the site had a further reduction in vegetation cover in 2015.

7.0 CLOSURE

VAST Resource Solutions trusts that this report satisfies your present requirements. Should you have any comments, please contact us at your convenience.

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Appendix 1: Site Descriptions, Characteristics, and Reservoir and Upland Plants Classifications

Site descriptions, characteristics, and possible influences in the drawdown zone of the Duncan Reservoir in 2015. Some tags required replacing resulting in new Transect number identification.

Site #	Side	Aspect	Camp-ground	Main Road Influence	Creek Influence	Transects	
						Tran. #	Length (m)
1	East	SW	Yes	No	No	1	0-320
						700/869	0-134
2	East	NW-W	No	Secondary Rd	No	701/884	0-304
						702/885	0-388
						703/822	0-360
3	East	N-NE	No	No	No	704	0-52
						812	0-48
4	East	NW-W	Yes	No	Yes	705	0-71
		E-SE				706	0-54
5	East	SW-W	No	No	No	707	0-130
						813	0-71
6	East	NW-W	No	Yes	Yes	708	0-101
						814	35
7	East	NW-N	Yes	No	No	2	0-40
						3	0-55
9	East	SW-W	Yes	No	No	709	0-92
			No	No	No	710	0-107
		NW-W				711	0-151
						712	0-168
10	East	NW-W	Yes	No	Yes	6	0-185
		S-SW	No	Yes	No	713	0-90
						714	0-84
11	West	N-NE	No	No	No	715	0-67
			No	No	Yes	716	0-71
12	West	NE-E	No	No	No	5	0-60
						718	0-52
13	West	N-NE	No	No	Yes	717	0-100
						4	0-100
		NE-E				719	0-100
						720	0-100

Reservoir Plants Identified below Full-Pool (576.7 m to 566.7 m elevation).

Abbreviations for tables:

Vegetation Classes:	Vegetation Group:	Status:
AG – Annual Grass	NOL – Upland	N – Native
PG – Perennial Grass	UPL – Obligate Upland	E – Exotic
AH – Annual Herb	OBL – Obligate Riparian	(NOX) – Noxious
PH – Perennial Herb	FAC – Facultative	(W) – Weed
WS – Woody Shrub	FACR – Facultative Riparian	(R) – Ruderal
WT – Woody Tree	FACU – Facultative Upland	
M – Moss		
F – Ferns		

Vegetation Group Descriptions

NOL – Upland species that does not occur in wetlands/riparian in another region. It is not on the national list (NOL).

UPL – Obligate upland species that occurs in wetlands in another region (estimated probability greater than 99%), but almost always occurs under natural conditions in non-riparian/wetlands in the region specified.

OBL – Obligate riparian species that almost always occurs under natural conditions in riparian zones (estimated probability greater than 99%).

FAC – Facultative species that is equally likely to occur in wetlands/riparian or uplands (estimated probability 34% - 66%).

FACR – Facultative riparian species that usually occurs in riparian/wetland habitat (estimated probability 67% - 99%), but is occasionally found in non-riparian/wetland habitat.

FACU – Facultative upland species that usually occurs in uplands (estimated probability 67% - 99%), but is occasionally found in wetland/riparian habitats (estimated probability 1% - 33%).

(R) – Ruderal species are first to colonize disturbed lands.

(+) & (-) Signs – used with facultative indicator categories to specify frequency toward the higher end of the category (+) more frequently found or the lower end of the category (-) less frequently found.

Traditional Use Plant Species are marked with *

Grass:

Scientific Name	Common Name	Species Code	Veg Class	Status	Veg Group
Agrostis gigantea	redtop	Agro_gig	PG	E	FACR (R)
Aira caryophyllea	silvery hairgrass	Aira_car	AG	E	NOL
Bromus anomalus	nodding brome	Brom_ano	PG	N	FAC
Bromus inermis	smooth broom	Brom_ine	PG	E	FAC+ (R)
Bromus tectorum	cheatgrass	Brom_tec	AG	E (W)	FAC
*Calamagrostis canadensis	blue-joint	Cala_can	PG	N	OBL(R)
Cinna latifolia	nodding wood-reed	Cinn_lat	PG	N	OBL(R)
Dactylis glomerata	orchard grass	Dact_glo	PG	E	FACU
Echinochloa crusgalli	banyard grass	Echi_cru	AG	E (W)	FAC
Elymus repens	quackgrass	Elym_rep	PG	E (W)	NOL(R)
Festuca campestris	rough fescue	Fest_cam	PG	N	NOL
*Phalaris arundinacea	reed-canary grass	Phal_aru	PG	N (W)	OBL

Herbaceous:

Scientific Name	Common Name	Species Code	Veg Class	Status	Veg Group
Apocynum androsaemifolium	spreading dogbane	Apoc_and	PH	N	NOL
Aster conspicuus	showy aster	Aste_con	PH	N	NOL
*Athyrium filix-femina	lady fern	Athy_fil	F	N	FAC
*Carex lasiocarpa	slender sedge	Care_las	PH	N	OBL
*Carex utriculata	beaked sedge	Care_utr	PH	N	OBL
Centaurea maculosa	spotted knapweed	Cent_mac	PH	E(NOX)	UPL (R)
Cerastium vulgatum	mouse-eared chickweed	Cera_vul	AH	N(W)	FACU (R)
Chenopodium album	lamb's-quarters	Chen_alb	AH	N(W)	FACU(R)
Chrysanthemum leucanthemum	oxeye daisy	Chry_leu	PH	E(W)	NOL(R)
Collomia linearis	narrow-leaved collomia	Coll_lin	AH	N	FACU
Dryas drummondii	yellow mountain avens	Drya_dru	PH	N	FACU
Epilobium angustifolium	fireweed	Epil_ang	PH	N(W)	FACU
*Equisetum arvense	common horsetail	Equi_arv	PH	N(W)	FACR
*Equisetum hyemale	scouring-rush	Equi_hye	PH	N	FACR
Equisetum sylvaticum	wood horsetail	Equi_syl	PH	N	FACR
Erysimum cheiranthoides	wormseed mustard	Erys_che	AH	N(W)	FACU
Euphorbia esula	leafy spurge	Euph_esu	PH	E(NOX)	FACU
Matricaria discoidea	pineapple weed	Matr_dis	AH	E(W)	FACU(R)
Medicago lupulina	black medick	Medi_lup	PH	E(W)	FACU
Mimulus guttatus	yellow monkey-flower	Mimu_gut	AH	N	OBL
	moss species	Moss spp	M	N	OBL
Myosotis laxa	small-flower forget-me-not	Myos_lax	PH	N	OBL
Oenothera villosa	evening primrose	Oeno_vil	PH	N	FAC

Scientific Name	Common Name	Species Code	Veg Class	Status	Veg Group
Pleurozium schreberi	Schreber's red stem (moss)	Pleu_sch	M	N	OBL
Polygonum douglasii	Douglas's knotweed	Poly_dou	AH	N	FACU
Polygonum lapathifolium	green smartweed	Poly_lap	AH	N(W)	OBL
Potentilla diversifolia	diverse-leaved Cinquefoil	Pote_div	PH	N	FAC
Prunella vulgaris	self-heal	Prun_vul	PH	N	FACR
Pteridium aquilinum	bracken	Pter_aqu	F	N(W)	FACU
Ranunculus acris	meadow buttercup	Ranu_acr	PH	E(W)	FACR-
Rumex crispus	curly dock	Rume_cri	PH	E(W)	FACR
Senecio vulgaris	groundsel common	Sene_vul	AH	E(NOX)	FACU
Streptococcus amplexifolius	clasping twisted stalk	Strep_amp	PH	N	FAC
Taraxacum officinale	dandelion	Tara_off	PH	E(W)	FACU
Trifolium arvense	hare's-foot clover	Trif_arv	AH	E	NOL
Trifolium pratense	red clover	Trif_pra	PH	E(W)	FACU
Trifolium repens	white clover	Trif_rep	PH	E(W)	FACU
Vicia americana	American vetch	Vici_ame	PH	N	FACU
Viola adunca	early blue violet	Viol_adu	PH	N	FAC

Shrubs:

Scientific Name	Common Name	Species Code	Veg Class	Status	Veg Group
Acer glabrum	Douglas maple	Acer_gla	WS	N	FACU+
*Amelanchier alnifolia	Saskatoon	Amel_aln	WS	N	FACU
Berberis aquifolium	Oregon-grape	Berb_aqu	WS	N	FACU
*Cornus stolonifera	red-osier dogwood	Corn_sto	WS	N	FACR
Linnaea borealis	twinflower	Linn_bor	WS	N	FACU-
Lonicera involucrata	black twinberry	Loni_inv	WS	N	FAC
Prunus virginiana	choke cherry	Prun_vir	WS	N	FAC
*Rubus parviflorus	thimbleberry	Rubu_par	WS	N	FAC
*Salix bebbiana	Bebb's willow	Sali_beb	WS	N	FACR
*Salix lucida	Pacific willow	Sali_luc	WS	N	FACR
*Salix scouleriana	Scouler’s willow	Sali_sco	WS	N	FAC
*Shepherdia canadensis	buffalo berry	Shep_can	WS	N	NOL
*Symphoricarpos albus	snowberry	Sym_alb	WS	N	FACU

Trees:

Scientific Name	Common Name	Species Code	Veg Class	Status	Veg Group
Betula occidentalis	water birch	Betu_occ	WT	N	FACR
*Betula papyrifera	paper birch	Betu_pap	WT	N	FACU
Picea glauca x engelmannii	hybrid white spruce	Pice_gla x	WT	N	FACU
Pinus contorta var. latifolia	lodgepole pine	Pinu_con	WT	N	FACU
Populus tremuloides	trembling aspen	Popu_tre	WT	N	FACU
*Populus trichocarpa	black cottonwood	Popu_tri	WT	N	FACR
Pseudotsuga menziessii var. glauca	interior Douglas fir	Pseu_men	WT	N	FACU
*Thuja plicata	western redcedar	Thuj_pli	WT	N	FACU

Upland species sampled from 576.7 m to 578.7 m elevation above full-pool. Traditional Use Plants marked with *.

Herbaceous:

Scientific Name	Common Name	Species Code
*Achillea millefolium	yarrow	Achi_mil
Agrostis gigantea	redtop	Agro_gig
Apocynum androsaemifolium	spreading dogbane	Apoc_and
Aralia nudicaulis	wild sarsaparilla	Aral_nud
Aster ciliolatus	Lindley's aster	Aste_cil
Aster conspicuus	showy aster	Aste_con
*Carex utriculata	beaked sedge	Care_utr
Centaurea maculosa	spotted knapweed	Cent_mac
Chrysanthemum leucanthemum	oxeye daisy	Chry_leu
Cinna latifolia	nodding wood-reed	Cinn_lat
Clintonia uniflora	queen's cup	Clin_uni
Corallorhiza maculata ssp maculata	spotted coralroot	Cora_mac
Cornus canadensis	bunchberry	Corn_can
Dryas drummondii	yellow mountain avens	Drya_dru
Epilobium angustifolium	fireweed	Epil_ang
*Equisetum arvense	common horsetail	Equi_arv
Equisetum sylvaticum	wood horsetail	Equi_syl
Festuca campestris	rough fescue	Fest_cam
Festuca spp	fescue tribe	Fest spp
*Fragaria virginiana	strawberry	Frag_vir
Goodyera oblongifolia	rattlesnake plantain	Good_obl
*Gymnocarpium dryopteris	oak fern	Gymn_dry
Hieracium albiflorum	white hawkweed	Hier_alb
Hieracium aurantiacum	orange hawkweed	Hier_aur
Hieracium umbellatum	narrow-leaved hawkweed	Hier_umb
*Lilies columbianum	tiger lily	Lili_col
*Maianthemun racemosum	false-solomon's seal	Maia_rac
Medicago lupulina	black medick	Medi_lup
	All moss species (2012)	Moss spp
Oryzopsis asperfolia	rough-leaved ricegrass	Oryz_asp
Pleurozium schreberi	Schreber's red stem (moss)	Pleu_sch
Prunella vulgaris	self-heal	Prun_vul
Pteridium aquilinum	bracken	Pter_aqu
Pyrola asarifolia	pink wintergreen	Pyro_asa
Stipa occidentalis	needlegrass	Stip_occ
Taraxacum officinale	dandelion	Tara_off
Trifolium arvense	hare's-foot clover	Trif_arv
Trifolium pratense	red clover	Trif_pra

Shrubs:

Scientific Name	Common Name	Species Code
Acer glabrum	Douglas maple	Acer_gla
Alnus crispa	Sitka alder	Alnu_cri
*Amelanchier alnifolia	Saskatoon	Amel_aln
Arctostaphylos uva-ursi	kinnikinnick	Arct_uva-urs
*Berberis aquifolium	Oregon-grape	Berb_aqu
Chimaphila umbellata	prince's-pine	Chim_umb
*Cornus stolonifera	red-osier dogwood	Corn_sto
Juniperus communis	common juniper	Juni_com
Linnaea borealis	twinflower	Linn_bor
Lonicera involucrata	black twinberry	Loni_inv
Lonicera utahensis	Utah honeysuckle	Loni. uta.
*Oplopanax horridus	devil's club	Oplo_hor
*Pachistima myrsinites	falsebox	Pach_myr
Prunus virginiana	choke cherry	Prun_vir
*Ribes lacustre	black gooseberry	Ribe_lac
*Rosa acicularis	prickly rose	Rosa_aci
*Rosa gymnocarpa	baldhip rose	Rosa_gym
*Rubus parviflorus	thimbleberry	Rubu_par
*Salix bebbiana	Bebb's willow	Sali_beb
*Salix lucida	pacific willow	Sali_luc
*Salix scouleriana	Scouler’s willow	Sali_sco
*Shepherdia canadensis	buffalo berry	Shep_can
Symphoricarpos albus	snowberry	Symp_alb
Taxus brevifolia	western yew	Taxu_bre
*Vaccinium membranaceum	black huckleberry	Vacc_mem
*Vaccinium ovalifolium	oval-leaved blueberry	Vacc_ova

Trees:

Scientific Name	Common Name	Species Code
*Betula papyrifera	paper birch	Betu_pap
Larix occidentalis	western larch	Lari_occ
Picea glauca	white spruce	Pice_gla
Pinus contorta var. latifolia	lodgepole pine	Pinu_con
Pinus monticola	western white pine	Pinu_mon
Populus tremuloides	trembling aspen	Popu_tre
*Populus trichocarpa	black cottonwood	Popu_tri
Pseudotsuga menziessii var. glauca	interior Douglas fir	Pseu_men
*Thuja plicata	western redcedar	Thuj_pli
Tsuga heterophylla	western hemlock	Tsug_het

Appendix 2: Reservoir Elevation Analyses Table

Duncan Reservoir elevation analyses for high riparian potential sites - 2014 growing season

Week #	*Average Elevation (m)*	2D surface area above average weekly reservoir elevation by site (m^2 and % of site)																	
		Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 10		Site 13	
		Area (m^2)	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)	%	Area (m^2)	%
1	549.40	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
2	548.22	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
3	547.37	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
4	546.97	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
5	547.21	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
6	548.29	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
7	549.02	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
8	552.04	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	77153.7	*100*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
9	555.52	60112.5	*100*	240242.6	*100*	10193.2	*100*	139546.4	*100*	76719.2	*99*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
10	558.42	59592.1	*99*	240242.6	*100*	9825.6	*96*	139546.4	*100*	74026.1	*96*	21094.2	*100*	5047.6	*100*	120070.3	*100*	67950.8	*100*
11	561.20	46979.0	*78*	238123.0	*99*	8318.0	*82*	139546.4	*100*	70303.9	*91*	20751.7	*98*	5047.6	*100*	120070.3	*100*	67950.8	*100*
12	563.95	36017.0	*60*	206807.2	*86*	6780.7	*67*	118788.5	*85*	63256.9	*82*	14823.2	*70*	4880.4	*97*	116023.8	*97*	67950.8	*100*
13	567.03	22899.7	*38*	157770.2	*66*	5369.3	*53*	77781.5	*56*	50930.0	*66*	9515.5	*45*	4253.8	*84*	74652.6	*62*	67950.8	*100*
14	569.91	14550.4	*24*	113610.5	*47*	3975.1	*39*	51090.0	*37*	30236.4	*39*	5368.8	*25*	3535.2	*70*	42406.4	*35*	67950.8	*100*
15	572.47	8095.0	*13*	71660.5	*30*	2436.8	*24*	23485.8	*17*	13076.5	*17*	3025.7	*14*	2699.2	*53*	25195.5	*21*	56059.6	*83*
16	574.48	3303.5	*5*	31017.7	*13*	942.8	*9*	10127.9	*7*	6210.2	*8*	2010.5	*10*	1831.8	*36*	13909.8	*12*	11790.0	*17*
17	575.67	1043.6	*2*	10937.2	*5*	263.3	*3*	3663.2	*3*	2871.2	*4*	1487.7	*7*	1084.5	*21*	6314.7	*5*	2978.0	*4*
18	576.31	125.4	*0*	2749.8	*1*	73.9	*1*	1793.1	*1*	1359.5	*2*	1217.0	*6*	581.6	*12*	2913.2	*2*	535.6	*1*
19	576.38	88.3	*0*	2347.0	*1*	61.6	*1*	1675.5	*1*	1235.4	*2*	1189.4	*6*	530.8	*11*	2532.6	*2*	429.0	*1*
20	576.43	60.2	*0*	2041.4	*1*	51.7	*1*	1589.5	*1*	1132.0	*1*	1165.3	*6*	484.6	*10*	2241.5	*2*	345.1	*1*
21	576.24	178.0	*0*	3344.1	*1*	90.1	*1*	1956.9	*1*	1519.0	*2*	1250.1	*6*	643.2	*13*	3381.4	*3*	684.4	*1*
22	575.65	1076.4	*2*	11229.2	*5*	273.9	*3*	3733.8	*3*	2917.5	*4*	1495.1	*7*	1097.9	*22*	6420.2	*5*	3100.4	*5*
23	574.92	2354.3	*4*	23560.4	*10*	694.1	*7*	7144.1	*5*	4941.0	*6*	1801.1	*9*	1587.6	*31*	11387.0	*9*	8047.5	*12*
24	573.70	5104.5	*8*	45557.3	*19*	1482.0	*15*	14471.5	*10*	8592.6	*11*	2422.8	*11*	2190.4	*43*	17789.9	*15*	23852.5	*35*
25	572.59	7817.7	*13*	69165.6	*29*	2347.3	*23*	22624.2	*16*	12554.0	*16*	2970.2	*14*	2654.6	*53*	24551.4	*20*	53428.9	*79*
26	571.87	9404.3	*16*	82246.5	*34*	2885.9	*28*	28295.7	*20*	16004.7	*21*	3350.7	*16*	2922.2	*58*	28627.2	*24*	66751.8	*98*
*85th Percentile**	575.98	527.9	*1*	6180.9	*3*	155.5	*2*	2605.2	*2*	2096.3	*3*	1358.0	*6*	844.6	*17*	4656.0	*4*	1454.8	*2*

* Represents the elevation at which the drawdown zone is exposed for 85 - 100% of the growing season

Appendix 3: Plant Community Analyses Table

Data summaries for areas (ha) of each vegetation type for the sites and total area (ha) for each community by site, as well as the grand totals for 2015. Last two columns are grand totals for 2012 and 2009 for each vegetation type and community.

Veg.Type	Community *(#1 dominant species)	S.1	S.2	S.3	S.4	S.5	S.6	S.7	S.9	S.10	S.11	S.12	S.13	S.14	2015 Total	2012 Total	2009 Total
Bare (ha)	B1 (bare)	0.06	6.66		0.25	0.72	1.88	0.38	2.95	7.95	0.51	1.15			22.51	16.32	15.56
	B2 (bare, trace vegetation)	0.11	16.53	0.73	5.90	1.41	0.23	0.12	2.23	4.00	0.80	0.66	2.39	0.30	35.40	7.91	0.11
Bare Total		**0.17**	**23.19**	**0.73**	**6.14**	**2.12**	**2.11**	**0.50**	**5.18**	**11.95**	**1.31**	**1.80**	**2.39**	**0.30**	**57.91**	**24.23**	**15.67**
Shrub (ha)	SH1 (shrub 1, cottonwood <2 m tall)	0.01	0.08							0.01				0.00	0.10	1.43	0.35
	SH2 (shrub 2, willow)								0.01				0.47	0.30	0.77	0.74	0.64
	SH3 **(shrub 3, other species)			0.05											0.06	0.59	0.53
Shrub Total		**0.01**	**0.08**	**0.05**					**0.01**	**0.01**			**0.47**	**0.30**	**0.93**	**2.76**	**1.52**
Tree (ha)	TR1 (tree, cottonwood > 2 m tall)		0.11												0.11	0.16	0.0032
	TR2 (tree, other species > 2 m tall)										0.0060				0.0060		0.00
Tree Total			**0.11**								**0.01**				**0.12**	**0.16**	**0.0032**
Herbaceous	H1 (herb 1, common horsetail)	1.02	0.17		0.54	0.74			0.30	0.01	0.01		3.73	19.19	25.73	27.64	28.58
(ha)	H2 (herb 2, beaked sedge)		0.30						0.02						0.32	1.23	1.40
	H3 (herb 3, green smartweed)					1.81									1.81	9.30	11.92
	H4 (herb 4, grasses)															0.72	30.70
	H5 (herb 5, narrow-leaved collomia)		0.12												0.12		1.85
	H6 (herb 6, small-flowered bulrush)					0.12			0.02						0.14	0.96	0.15
	H7 (herb 7, lamb's-quarters)																7.09
	H8 (herb 8, spotted knapweed)																0.07
	H9 (herb 9, yellow mountain avens)									0.04					0.04	0.05	0.06
	H10 (herb 10, evening primrose)		0.04												0.04	0.06	0.03
	H11 (herb 11, yellow monkey-flower)				0.03										0.03	3.14	3.52
	H12 (herb 12, cottonwood < 0.5 m tall)																0.03
	H13 (herb 13, nodding wood-reed)	1.06		0.24									0.21		1.51	6.32	
	H14 (herb 14, wormseed mustard)	3.74													3.74	0.28	
	H15 (herb 15, mouse-eared chickweed)															25.75	
	H16 (herb 16, silver hair-grass)				7.23	2.93									10.16		
Herb Total		**5.83**	**0.64**	**0.24**	**7.81**	**5.59**			**0.34**	**0.05**	**0.01**		**3.94**	**19.19**	**43.63**	**75.45**	**85.40**
Grand Total (= site area)		***6.01***	***24.02***	***1.02***	***13.95***	***7.72***	***2.11***	***0.50***	***5.52***	***12.01***	***1.33***	***1.80***	***6.80***	***19.79***	***102.59***	***102.60***	***102.59***

*Species listed for each community number one dominant species.
**SH3 = dominant shrub species other than cottonwood or willow.

Appendix 4: Statistical Analyses Tables

Regression analyses for vegetation cover and species diversity versus substrate index.

Sub 2015 = 3.068 - (0.00917 * Cover 2015) Vegetation Cover

N = 627

R = 0.265 Rsqr = 0.0700 Adj Rsqr = 0.0685

Standard Error of Estimate = 1.093

	Coefficient	Std. Error	t	P
Constant	3.068	0.0523	58.699	<0.001
Cover 2015	-0.00917	0.00134	-6.859	<0.001

Analysis of Variance:

	DF	SS	MS	F	P
Regression	1	56.164	56.164	47.04	<0.001
Residual	625	746.228	1.194		
Total	626	802.392	1.282		

Normality Test (Shapiro-Wilk) Failed (P = <0.001)

Constant Variance Test: Passed (P = 0.324)

Power of performed test with alpha = 0.050: 1.000

Sub 2015 = 2.979 - (0.238 * SW 2015) Species diversity Index 'SW'

N = 627

R = 0.0997 Rsqr = 0.00993 Adj Rsqr = 0.00835

Standard Error of Estimate = 1.127

	Coefficient	Std. Error	t	P
Constant	2.979	0.0622	47.875	<0.001
SW 2015	-0.238	0.0949	-2.504	0.013

Analysis of Variance:

	DF	SS	MS	F	P
Regression	1	7.969	7.969	6.27	0.013
Residual	625	794.423	1.271		
Total	626	802.392	1.282		

Normality Test (Shapiro-Wilk) Failed (P = <0.001)

Constant Variance Test: Passed (P = 0.839)

Power of performed test with alpha = 0.050: 0.705

Linear Regression **For Species Diversity by Site comparison 2009 to 2012, and 2015**

09 SW/Sites = 1.162 + (1.181 * 15 SW/Sites)

N = 12

R = 0.644	Rsqr = 0.414	Adj Rsqr = 0.356

Standard Error of Estimate = 0.497

	Coefficient	Std. Error	t	P
Constant	1.162	0.253	4.583	0.001
15 SW/Sites	1.181	0.444	2.659	0.024

Analysis of Variance:

	DF	SS	MS	F	P
Regression	1	1.749	1.749	7.072	0.024
Residual	10	2.473	0.247		
Total	11	4.221	0.384		

Normality Test (Shapiro-Wilk)	Passed	(P = 0.266)
Constant Variance Test:	Passed	(P = 0.071)

Power of performed test with alpha = 0.050: 0.630

Regression test for difference between years for the 85th percentile area

2009 vs 2014

Regression Statistics	
Multiple R	0.940110382
R Square	0.88380753
Adjusted R Square	0.867208606
Standard Error	3.033103034
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	489.8375575	489.8376	53.24487	0.000163194
Residual	7	64.3979981	9.199714		
Total	8	554.2355556			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	3.592	1.378	2.607	0.035	0.333	6.850
2014	1.589	0.218	7.297	0.000163	1.074	2.104

2011 vs 2014

Regression Statistics	
Multiple R	0.982456728
R Square	0.965221222
Adjusted R Square	0.960252825
Standard Error	1.303721052
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	330.2021799	330.2022	194.2722	2.31469E-06
Residual	7	11.89782007	1.699689		
Total	8	342.1			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1.325	0.592	2.237	0.060	-0.075	2.726
2014	1.305	0.094	13.938	2.31E-06	1.084	1.526

Linear Regression Vegetated area 2009 compared to 2015

V 09 = 3.083 + (0.841 * V 15)

N = 16

R = 0.558 Rsqr = 0.312 Adj Rsqr = 0.262

Standard Error of Estimate = 8.583

	Coefficient	**Std. Error**	**t**	**P**
Constant	3.083	2.340	1.318	0.209
V 15	0.841	0.334	2.518	0.025

Analysis of Variance:

	DF	**SS**	**MS**	**F**	**P**
Regression	1	466.951	466.951	6.338	0.025
Residual	14	1031.426	73.673		
Total	15	1498.377	99.892		

Normality Test (Shapiro-Wilk) Failed (P = <0.001)

Constant Variance Test: Passed (P = 0.066)

Power of performed test with alpha = 0.050: 0.623

Appendix 5: Photo Documentation

Date: June 10, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S1 T1	0.0	0	DSCN_2860	Herb Plot
	1.0		DSCN_2861	Looking at POC
	1.0		DSCN_2862	Looking down line
	1.0		DSCN_2863	Up reservoir
	1.0		DSCN_2864	Down reservoir
	86.6	-2	DSCN_2866	Herb Plot
	87.7		DSCN_2867	Looking at POC
	87.7		DSCN_2868	Looking down line
	87.7		DSCN_2869	Up reservoir
	87.7		DSCN_2870	Down reservoir
	140.0	-4	DSCN_2875	Herb Plot
	140.0		DSCN_2876	Looking at POC
	140.0		DSCN_2877	Looking down line
	140.0		DSCN_2878	Up reservoir
	140.0		DSCN_2879	Down reservoir
	177.0	-6	DSCN_2880	Herb Plot
	178.0		DSCN_2881	Looking at POC
	178.0		DSCN_2882	Looking down line
	178.0		DSCN_2883	Up reservoir
	178.0		DSCN_2884	Down reservoir
	212.0	-8	DSCN_2886	Herb Plot
	212.0		DSCN_2888	Looking at POC
	212.0		DSCN_2889	Looking down line
	212.0		DSCN_2890	Up reservoir
	212.0		DSCN_2891	Down reservoir
	278.1	-10	DSCN_2894	Herb Plot
	279.1		DSCN_2895	Looking at POC
	279.1		DSCN_2896	Looking down line
	279.1		DSCN_2897	Up reservoir
	279.1		DSCN_2898	Down reservoir
	12.0		DSCN_2910	Herb Plot
	21.9		DSCN_2913	Herb Plot
	23.7		DSCN_2914	Herb Plot
	40.7		DSCN_2920	Herb Plot
	79.7		DSCN_2915	Herb Plot
Upland	0	0	DSCN_2899	Looking at POC
	-15		DSCN_2902	Looking into tree plot
	-15		DSCN_2906	Herb Plot
	-18		DSCN_2903	Looking at EOT
	-31	2	DSCN_2904	EOT

Date: June 10, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S1 Tr700	0.0	0	DSCN_2807	Herb Plot
New: Tr869	1.0		DSCN_2808	Looking at POC
	1.0		DSCN_2809	Looking down line
	1.0		DSCN_2810	Up reservoir
	1.0		DSCN_2811	Down reservoir
	17.0	-2	DSCN_2812	Herb Plot
	18.0		DSCN_2813	Looking at POC
	18.0		DSCN_2814	Looking down line
	18.0		DSCN_2815	Up reservoir
	18.0		DSCN_2816	Down reservoir
	30.4	-4	DSCN_2817	Herb Plot
	31.4		DSCN_2818	Looking at POC
	31.4		DSCN_2819	Looking down line
	31.4		DSCN_2820	Up reservoir
	31.4		DSCN_2821	Down reservoir
	59.9	-6	DSCN_2823	Herb Plot
	60.9		DSCN_2824	Looking at POC
	60.9		DSCN_2825	Looking down line
	60.9		DSCN_2826	Up reservoir
	60.9		DSCN_2827	Down reservoir
	96.5	-8	DSCN_2828	Herb Plot
	97.5		DSCN_2829	Looking at POC
	97.5		DSCN_2830	Looking down line
	97.5		DSCN_2831	Up reservoir
	97.5		DSCN_2832	Down reservoir
	133.6	-10	DSCN_2834	Herb Plot
	133.6		DSCN_2835	Looking at POC
	133.6		DSCN_2836	Looking down line
	133.6		DSCN_2837	Up reservoir
	133.6		DSCN_2838	Down reservoir
	8.8		DSCN_2849	Herb Plot
	24.5		DSCN_2850	Herb Plot
	65.8		DSCN_2852	Herb Plot
	82.7		DSCN_2853	Herb Plot
	117.5		DSCN_2857	Herb Plot
Upland	0.0	0	DSCN_2839	Looking down line
	-4.0		DSCN_2840	Looking down line
	-9.0		DSCN_2841	Looking down line
	-9.0		DSCN_2842	Up reservoir
	-19.0		DSCN_2843	Looking down line
	-19.0		DSCN_2844	Up reservoir
	-19.0		DSCN_2845	Down reservoir
	-24.0	2	DSCN_2846	EOT

Date: June 9, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S2 T701	0.0	0	DSCN_2762	Tree Plot
New: T884	1.0		DSCN_2724	Looking at POC
	1.0		DSCN_2725	Looking down line
	1.0		DSCN_2726	Up reservoir
	1.0		DSCN_2727	Down reservoir
	28.0	-2	DSCN_2728	Herb Plot
	29.0		DSCN_2729	Looking at POC
	29.0		DSCN_2730	Looking down line
	29.0		DSCN_2731	Up reservoir
	29.0		DSCN_2732	Down reservoir
	57.0	-4	DSCN_2733	Herb Plot
	58.0		DSCN_2734	Looking at POC
	58.0		DSCN_2735	looking down line
	58.0		DSCN_2736	up reservoir
	58.0		DSCN_2737	down reservoir
	162.0	-6	DSCN_2738	Herb Plot
	163.0		DSCN_2739	Looking at POC
	163.0		DSCN_2740	Looking down line
	163.0		DSCN_2741	Up reservoir
	163.0		DSCN_2742	Down reservoir
	237.0	-8	DSCN_2744	Herb Plot
	238.0		DSCN_2745	Looking at POC
	238.0		DSCN_2746	Looking down line
	238.0		DSCN_2747	Up reservoir
	238.0		DSCN_2748	Down reservoir
	287.0	-10	DSCN_2750	Herb Plot
	288.0		DSCN_2751	Looking at POC
	288.0		DSCN_2752	Looking down line
	288.0		DSCN_2753	Up reservoir
	288.0		DSCN_2754	Down reservoir
	54.0		DSCN_2760	Herb Plot
	114.0		DSCN_2759	Herb Plot
	220.4		DSCN_2758	Herb Plot
	226.0		DSCN_2756	Herb Plot
	265.6		DSCN_2755	Herb Plot
Upland	0.0	0	DSCN_2763	Looking at POC
	-6.0		DSCN_2764	Looking down line
	-6.0		DSCN_2765	Up reservoir
	-6.0		DSCN_2767	Down reservoir
	-15.0		DSCN_2768	Looking down line
	-15.0		DSCN_2769	Up reservoir
	-15.0		DSCN_2770	Down reservoir
	-25.0	2	DSCN_2771	EOT

Date: June 9, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S2 T702	0.0	0	DSCN_2772	Herb Plot
New: T885	1.0		DSCN_2773	Looking at POC
	1.0		DSCN_2774	Looking down line
	1.0		DSCN_2775	Up reservoir
	1.0		DSCN_2776	Down reservoir
	60.0	-1	DSCN_2777	Herb Plot
	61.0		DSCN_2778	Looking at POC
	61.0		DSCN_2779	Looking down line
	61.0		DSCN_2780	Up reservoir
	61.0		DSCN_2781	Down reservoir
	84.0	-2	DSCN_2782	Herb Plot
	85.0		DSCN_2783	Looking at POC
	85.0		DSCN_2784	Looking down line
	85.0		DSCN_2785	Up reservoir
	85.0		DSCN_2786	Down reservoir
	150.0	-4	DSCN_2787	Herb Plot
	151.0		DSCN_2788	Looking at POC
	151.0		DSCN_2789	Looking down line
	151.0		DSCN_2790	Up reservoir
	151.0		DSCN_2791	Down reservoir
	225.0	-6	DSCN_2792	Herb Plot
	226.0		DSCN_2793	Looking at POC
	226.0		DSCN_2794	Looking down line
	226.0		DSCN_2795	Up reservoir
	226.0		DSCN_2796	Down reservoir
	294.0	-8	camera died	Herb Plot
	295.0		camera died	Looking at POC
	295.0		camera died	Looking down line
	295.0		camera died	Up reservoir
	295.0		camera died	Down reservoir
	388.0	-10	DSCN_2806	Herb Plot
	389.0		camera died	Looking at POC
	389.0		camera died	Looking down line
	389.0		camera died	Up reservoir
	389.0		camera died	Down reservoir
Upland	0.0	0	DSCN_2797	Looking at POC
	0.0		DSCN_2798	Up line
	-15.0		DSCN_2803	Herb Plot (DSCN_2799-2802)
	-21.0		DSCN_2804	Looking at POC
	-20.0	2	DSCN_2805	EOT

Date: June 9, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S2 T703	10.0	0	DSCN_2673	Herb Plot (DSCN_2669-2672)
New: T822	11.0		DSCN_2674	Looking at POC
	11.0		DSCN_2675	Looking down line
	11.0		DSCN_2676	Up reservoir
	11.0		DSCN_2677	Down reservoir
	29.0	-2	DSCN_2679	Herb Plot (DSCN_2678)
	30.0		DSCN_2680	Looking at POC
	30.0		DSCN_2681	Looking down line
	30.0		DSCN_2682	Up reservoir
	30.0		DSCN_2683	Down reservoir
	150.0	-4	DSCN_2685	Herb Plot (DSCN_2684,2686)
	151.0		DSCN_2687	Looking at POC
	151.0		DSCN_2688	Looking down line
	151.0		DSCN_2689	Up reservoir
	151.0		DSCN_2690	Down reservoir
	246.0	-6	DSCN_2695	Herb Plot (DSCN_2691-2694)
	247.0		DSCN_2696	Looking at POC
	247.0		DSCN_2697	Looking down line
	247.0		DSCN_2698	Up reservoir
	247.0		DSCN_2699	Down reservoir
	282.0	-8	DSCN_2700	Herb plot
	283.0		DSCN_2701	Looking at POC
	283.0		DSCN_2702	Looking down line
	283.0		DSCN_2703	Up reservoir
	283.0		DSCN_2704	Down reservoir
	360.0	-10	DSCN_2712	H Plot
	361.0		DSCN_2713	Looking at POC
	361.0		DSCN_2714	Looking down line
	361.0		DSCN_2715	Up reservoir
	361.0		DSCN_2716	Down reservoir
	177.6		DSCN_2722	Herb plot
	275.7		DSCN_2721	Herb plot
	295.0		DSCN_2720	Herb plot
	321.3		DSCN_2719	Herb plot
	346.0		DSCN_2718	Herb plot
Upland	0.0	0	DSCN_2705	Looking at POC
	-5.0		DSCN_2706	Up line
	-5.0		DSCN_2707	Down line
	-19.0		DSCN_2708	Down line
	-24.0	2	DSCN_2709	Up line
	-24.0		DSCN_2710	EOT

Date: June 9, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S3_Tr704	0.0	0	DSCN_2568	Herb Plot (DSCN 2566,2567)
	1.0		DSCN_2569	Looking at POC
	1.0		DSCN_2570	Looking down line
	1.0		DSCN_2571	Up reservoir
	1.0		DSCN_2572	Down reservoir
	10.0	-2	DSCN_2573	Herb plot
	11.0		DSCN_2575	Looking at POC
	11.0		DSCN_2576	Looking down line
	11.0		DSCN_2577	Up reservoir
	11.0		DSCN_2578	Down reservoir
	16.0	-4	DSCN_2579	Herb plot
	17.0		DSCN_2580	Looking at POC
	17.0		DSCN_2581	Looking down line
	17.0		DSCN_2582	Up reservoir
	17.0		DSCN_2583	Down reservoir
	31.0	-6	DSCN_2588	Herb Plot (DSCN 2584-2587)
	32.0		DSCN_2589	Looking at POC
	32.0		DSCN_2590	Looking down line
	32.0		DSCN_2591	Up reservoir
	32.0		DSCN_2592	Down reservoir
	43.0	-8	DSCN_2599	Herb Plot (DSCN 2593-2598)
	44.0		DSCN_2600	Looking at POC
	44.0		DSCN_2601	Looking down line
	44.0		DSCN_2602	Up reservoir
	44.0		DSCN_2603	Down reservoir
	64.0	-10	DSCN_2605	Herb Plot
	65.0		DSCN_2606	Looking at POC
	65.0		DSCN_2607	Looking down line
	65.0		DSCN_2608	Up reservoir
	65.0		DSCN_2609	Down reservoir
	44.0		DSCN_2604	Waters edge, off line
Upland	-1.0	0	DSCN_2610	Looking up line at EOT
	-5.0		DSCN_2611	Up reservoir
	-5.0		DSCN_2612	Down reservoir
	-25.0	2	DSCN_2613	EOT

Date: June 9, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S3Tr812	7.0	0	DSCN_2618	Herb Plot (DSCN 2614-2617)
	8.0		DSCN_2619	Looking at POC
	8.0		DSCN_2620	Looking down line
	8.0		DSCN_2621	Up reservoir
	8.0		DSCN_2622	Down reservoir
	17.0	-2	DSCN_2625	Herb Plot
	18.0		DSCN_2626	Looking at POC
	18.0		DSCN_2627	Looking down line
	18.0		DSCN_2628	Up reservoir
	18.0		DSCN_2630	Down reservoir
	25.3	-4	DSCN_2632	Herb Plot
	26.3		DSCN_2633	Looking at POC
	26.3		DSCN_2634	Looking down line
	26.3		DSCN_2635	Up reservoir
	26.3		DSCN_2636	Down reservoir
	29.4	-6	DSCN_2637	Herb Plot
	30.4		DSCN_2638	Looking at POC
	30.4		DSCN_2639	Looking down line
	30.4		DSCN_2640	Up reservoir
	30.4		DSCN_2641	Down reservoir
	36.3	-8	DSCN_2645	Herb Plot
	37.3		DSCN_2646	Looking at POC
	37.3		DSCN_2647	Looking down line
	37.3		DSCN_2648	Up reservoir
	37.3		DSCN_2649	Down reservoir
	47.0	-10	DSCN_2650	Herb Plot
	48.0		DSCN_2651	Looking at POC
	48.0		DSCN_2652	Looking down line
	48.0		DSCN_2653	Up reservoir
	48.0		DSCN_2654	Down reservoir
	9.0		DSCN_2661	Herb Plot
	15.0		DSCN_2662	Herb Plot
	12.0		DSCN_2663	Herb Plot
	19.3		DSCN_2666	Herb Plot
	32.0		DSCN_2668	Herb Plot
Upland	-1.0	0	DSCN_2656	Up line
	-1.0		DSCN_2657	Down line
	-5.0		DSCN_2658	Up line
	-5.0		DSCN_2659	Down line
	-6.0	2	DSCN_2660	EOT

Date: June 10, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S4 705	0.0	0	DSCN_3059	Herb Plot
	1.0		DSCN_3058	Looking at POC
	1.0		DSCN_3057	Looking down line
	1.0		DSCN_3056	Up reservoir
	1.0		DSCN_3055	Down reservoir
	13.0	-2	DSCN_3054	Herb Plot
	14.0		DSCN_3053	Looking at POC
	14.0		DSCN_3052	Looking down line
	14.0		DSCN_3051	Up reservoir
	14.0		DSCN_3050	Down reservoir
	29.5	-4	DSCN_3049	Herb Plot
	30.5		DSCN_3048	Looking at POC
	30.5		DSCN_3047	Looking down line
	30.5		DSCN_3046	Up reservoir
	30.5		DSCN_3045	Down reservoir
	49.5	-6	DSCN_3044	Herb Plot
	50.5		DSCN_3043	Looking at POC
	50.5		DSCN_3042	Looking down line
	50.5		DSCN_3041	Up reservoir
	50.5		DSCN_3040	Down reservoir
	61.5	-8	DSCN_3039	Herb Plot
	62.5		DSCN_3038	Looking at POC
	62.5		DSCN_3037	Looking down line
	62.5		DSCN_3036	Up reservoir
	62.5		DSCN_3035	Down reservoir
	73.5	-10	DSCN_3034	Herb Plot
	74.5		DSCN_3033	Looking at POC
	74.5		DSCN_3032	Looking down line
	74.5		DSCN_3031	Up reservoir
	74.5		DSCN_3030	Down reservoir
Upland	-4.0	0	DSCN_3029	Down line
	-4.0		DSCN_3028	Up line
	-4.0		DSCN_3027	Up reservoir
	-4.0		DSCN_3026	Down reservoir
	-7.0		DSCN_3025	Down line
	-7.0		DSCN_3024	Up line
	-12.0	2	DSCN_3023	EOT

Date: June 10, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S4 706	1.0	0	DSCN_2522	Herb Plot
	2.0		DSCN_2528	Looking at POC
	2.0		DSCN_2529	Looking down line
	2.0		DSCN_2530	Up reservoir
	2.0		DSCN_2531	Down reservoir
	7.0	-2	DSCN_2532	Herb Plot
	8.0		DSCN_2533	Looking at POC
	8.0		DSCN_2534	Looking down line
	8.0		DSCN_2535	Up reservoir
	8.0		DSCN_2536	Down reservoir
	21.0	-4	DSCN_2537	Herb Plot
	22.0		DSCN_2538	Looking at POC
	22.0		DSCN_2539	Looking down line
	22.0		DSCN_2540	Up reservoir
	22.0		DSCN_2541	Down reservoir
	36.0	-6	DSCN_2543	Herb Plot
	37.0		DSCN_2544	Looking at POC
	37.0		DSCN_2545	Looking down line
	37.0		DSCN_2546	Up reservoir
	37.0		DSCN_2547	Down reservoir
	50.0	-8	DSCN_2548	Herb Plot
	51.0		DSCN_2549	Looking at POC
	51.0		DSCN_2550	Looking down line
	51.0		DSCN_2551	Up reservoir
	51.0		DSCN_2552	Down reservoir
	54.0	-10	DSCN_2553	Herb Plot
	55.0		DSCN_2554	Looking at POC
	55.0		DSCN_2555	Looking down line
	55.0		DSCN_2556	Up reservoir
	55.0		DSCN_2557	Down reservoir
	1.0		DSCN_2523	Looking at POC
	2.0		DSCN_2524	Down line
	2.0		DSCN_2525	Up reservoir
	2.0		DSCN_2526	Down reservoir
	1.0		DSCN_2527	Herb Plot
Upland	-1.0	0	DSCN_2559	Up line
	-1.0		DSCN_2560	Down reservoir
	-5.0		DSCN_2561	Down line
	-5.0		DSCN_2562	Up reservoir
	-5.0		DSCN_2563	Up line
	-6.0	2	DSCN_2564	EOT
	-5.0		DSCN_2565	Down reservoir

Date: June 10, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S5_Tr 707	0.0	0	DSCN_2974	Herb Plot
	1.0		DSCN_2975	Looking at POC
	1.0		DSCN_2976	Looking down line
	1.0		DSCN_2977	Up reservoir
	1.0		DSCN_2978	Down reservoir
	37.0	-2	DSCN_2979	Herb Plot
	38.0		DSCN_2980	Looking at POC
	38.0		DSCN_2981	Looking down line
	38.0		DSCN_2982	Up reservoir
	38.0		DSCN_2983	Down reservoir
	60.0	-4	DSCN_2986	Herb Plot
	61.0		DSCN_2987	Looking at POC
	61.0		DSCN_2988	Looking down line
	61.0		DSCN_2989	Up reservoir
	61.0		DSCN_2990	Down reservoir
	83.0	-6	DSCN_2991	Herb Plot
	84.0		DSCN_2992	Looking at POC
	84.0		DSCN_2993	Looking down line
	84.0		DSCN_2994	Up reservoir
	84.0		DSCN_2995	Down reservoir
	105.0	-8	DSCN_2996	Herb Plot
	106.0		DSCN_2998	Looking at POC
	106.0		DSCN_2999	Looking down line
	106.0		DSCN_3000	Up reservoir
	106.0		DSCN_3001	Down reservoir
	128.0	-10	DSCN_3003	Herb Plot
	129.0		DSCN_3006	Looking at POC
	129.0		DSCN_3007	Looking down line
	129.0		DSCN_3008	Up reservoir
	129.0		DSCN_3009	Down reservoir
	65.6		DSCN_3012	Herb Plot
	30.5		DSCN_3013	Herb Plot
	22.2		DSCN_3015	Herb Plot
	18.4		DSCN_3017	Herb Plot
Upland	-1.0	0	DSCN_3018	Down line
	-5.0		DSCN_3019	Down reservoir
	-6.0		DSCN_3020	Up reservoir
	-12.0		DSCN_3021	Up line
	-12.0	2	DSCN_3022	EOT

Date: June 10, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S5_Tr 813	4.0	0	DSCN_2921	Herb Plot
	5.0		DSCN_2922	Looking at POC
	5.0		DSCN_2923	Looking down line
	5.0		DSCN_2924	Up reservoir
	5.0		DSCN_2925	Down reservoir
	23.4	-2	DSCN_2927	Herb Plot
	24.4		DSCN_2928	Looking at POC
	24.4		DSCN_2929	Looking down line
	24.4		DSCN_2930	Up reservoir
	24.4		DSCN_2931	Down reservoir
	35.6	-4	DSCN_2935	Herb Plot
	36.6		DSCN_2936	Looking at POC
	36.6		DSCN_2937	Looking down line
	36.6		DSCN_2938	Up reservoir
	36.6		DSCN_2939	Down reservoir
	47.0	-6	DSCN_2940	Herb Plot
	48.0		DSCN_2941	Looking at POC
	48.0		DSCN_2942	Looking down line
	48.0		DSCN_2943	Up reservoir
	48.0		DSCN_2944	Down reservoir
	59.7	-8	DSCN_2946	Herb Plot
	60.7		DSCN_2947	Looking at POC
	60.7		DSCN_2948	Looking down line
	60.7		DSCN_2949	Up reservoir
	60.7		DSCN_2951	Down reservoir
	71.4	-10	DSCN_2954	Herb Plot
	72.4		DSCN_2955	Looking at POC
	72.4		DSCN_2956	Looking down line
	72.4		DSCN_2957	Up reservoir
	72.4		DSCN_2958	Down reservoir
	52.0		DSCN_2961	Herb Plot
	31.0		DSCN_2962	Herb Plot
	15.0		DSCN_2965	Herb Plot
	7.0		DSCN_2966	Herb Plot
Upland	-1.0	0	DSCN_2967	Down line
	-5.0		DSCN_2968	Down reservoir
	-6.0		DSCN_2969	Up reservoir
	-12.0		DSCN_2970	Up line
	-12.0	2	DSCN_2971	EOT

Date: June 12, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S6_Tr 708	7.0	0	DSCN_3668	Herb Plot
	8.0		DSCN_3669	Looking at POC
	8.0		DSCN_3670	Looking down line
	8.0		DSCN_3671	Up reservoir
	8.0		DSCN_3672	Down reservoir
	13.0	-2	DSCN_3673	Herb Plot
	14.0		DSCN_3674	Looking at POC
	14.0		DSCN_3675	Looking down line
	14.0		DSCN_3676	Up reservoir
	14.0		DSCN_3677	Down reservoir
	26.0	-4	DSCN_3678	Herb Plot
	27.0		DSCN_3679	Looking at POC
	27.0		DSCN_3680	Looking down line
	27.0		DSCN_3681	Up reservoir
	27.0		DSCN_3682	Down reservoir
	37.0	-6	DSCN_3683	Herb Plot
	38.0		DSCN_3684	Looking at POC
	38.0		DSCN_3685	Looking down line
	38.0		DSCN_3686	Up reservoir
	38.0		DSCN_3687	Down reservoir
	48.0	-8	DSCN_3688	Herb Plot
	49.0		DSCN_3689	Looking at POC
	49.0		DSCN_3690	Looking down line
	49.0		DSCN_3691	Up reservoir
	49.0		DSCN_3692	Down reservoir
	55.0	-10	DSCN_3693	Herb Plot
	56.0		DSCN_3694	Looking at POC
	56.0		DSCN_3695	Looking down line
	56.0		DSCN_3696	Up reservoir
	56.0		DSCN_3697	Down reservoir
Upland	-12.0	0	DSCN_3662	Up line
	-12.0		DSCN_3663	Down line
	-12.0		DSCN_3664	Down reservoir
	-12.0		DSCN_3665	Up reservoir
	-27.0	2	DSCN_3666	EOT - New EOT at -14 m
	-27.0	2	DSCN_3667	Looking across the creek at old EOT

Date: June 12, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S6_Tr814	1.0	0	DSCN_3703	Herb Plot
	1.0		DSCN_3704	Looking at POC
	1.0		DSCN_3705	Looking down line
	1.0		DSCN_3706	Up reservoir
	1.0		DSCN_3707	Down reservoir
	7.7	-2	DSCN_3708	Herb Plot
	8.7		DSCN_3709	Looking at POC
	8.7		DSCN_3710	Looking down line
	8.7		DSCN_3711	Up reservoir
	8.7		DSCN_3712	Down reservoir
	12.4	-4	DSCN_3713	Herb Plot
	13.4		DSCN_3714	Looking at POC
	13.4		DSCN_3715	Looking down line
	13.4		DSCN_3716	Up reservoir
	13.4		DSCN_3717	Down reservoir
	18.3	-6	DSCN_3718	Herb Plot
	19.3		DSCN_3719	Looking at POC
	19.3		DSCN_3720	Looking down line
	19.3		DSCN_3721	Up reservoir
	19.3		DSCN_3722	Down reservoir
	26.0	-8	DSCN_3723	Herb Plot
	27.0		DSCN_3724	Looking at POC
	27.0		DSCN_3725	Looking down line
	27.0		DSCN_3726	Up reservoir
	27.0		DSCN_3727	Down reservoir
	35.3	-10	DSCN_3728	Herb Plot
	36.3		DSCN_3729	Looking at POC
	36.3		DSCN_3730	Looking down line
	36.3		DSCN_3731	Up reservoir
	36.3		DSCN_3732	Down reservoir
Upland	-1.0		DSCN_3698	Down line
	-8.0		DSCN_3699	Up line
	-8.0		DSCN_3700	Up reservoir
	-8.0		DSCN_3702	Down reservoir

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S7_Tr 2	0.0	0	DSCN_3109	Herb Plot
	1.0		DSCN_3110	Looking at POC
	1.0		DSCN_3111	Looking down line
	1.0		DSCN_3112	Up reservoir
	1.0		DSCN_3113	Down reservoir
	20.0	-2	DSCN_3119	Herb Plot
	21.0		DSCN_3120	Looking at POC
	21.0		DSCN_3121	Looking down line
	21.0		DSCN_3122	Up reservoir
	21.0		DSCN_3123	Down reservoir
	27.0	-4	DSCN_3124	Herb Plot
	28.0		DSCN_3125	Looking at POC
	28.0		DSCN_3126	Looking down line
	28.0		DSCN_3127	Up reservoir
	28.0		DSCN_3128	Down reservoir
	32.0	-6	DSCN_3130	Herb Plot
	33.0		DSCN_3131	Looking at POC
	33.0		DSCN_3132	Looking down line
	33.0		DSCN_3133	Up reservoir
	33.0		DSCN_3134	Down reservoir
	37.0	-8	DSCN_3135	Herb Plot
	38.0		DSCN_3136	Looking at POC
	38.0		DSCN_3137	Looking down line
	38.0		DSCN_3138	Up reservoir
	38.0		DSCN_3139	Down reservoir
	42.0	-10	DSCN_3145	Herb Plot
	43.0		DSCN_3146	Looking at POC
	43.0		DSCN_3147	Looking down line
	43.0		DSCN_3148	Up reservoir
	43.0		DSCN_3149	Down reservoir
Upland	0.0	0	DSCN_3150	Down line
	-4.0		DSCN_3151	Up reservoir
	-10.0		DSCN_3152	Down/Res side at line
	-12.0		DSCN_3154	Up/Res side at line
	-19.0		DSCN_3155	Down reservoir
	-24.0	2	DSCN_3156	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S7_Tr3	0.0	0	DSCN_3060	Herb Plot
	1.0		DSCN_3062	Looking at POC
	1.0		DSCN_3063	Looking down line
	1.0		DSCN_3064	Up reservoir
	1.0		DSCN_3065	Down reservoir
	9.0	-2	DSCN_3066	Herb Plot
	10.0		DSCN_3067	Looking at POC
	10.0		DSCN_3068	Looking down line
	10.0		DSCN_3069	Up reservoir
	10.0		DSCN_3070	Down reservoir
	25.0	-4	DSCN_3072	Herb Plot
	26.0		DSCN_3074	Looking at POC
	26.0		DSCN_3075	Looking down line
	26.0		DSCN_3076	Up reservoir
	26.0		DSCN_3077	Down reservoir
	32.0	-6	DSCN_3079	Herb Plot
	33.0		DSCN_3081	Looking at POC
	33.0		DSCN_3082	Looking down line
	33.0		DSCN_3083	Up reservoir
	33.0		DSCN_3084	Down reservoir
	41.0	-8	DSCN_3087	Herb Plot
	42.0		DSCN_3088	Looking at POC
	42.0		DSCN_3089	Looking down line
	42.0		DSCN_3090	Up reservoir
	42.0		DSCN_3091	Down reservoir
	45.0	-10	DSCN_3095	Herb Plot
	46.0		DSCN_3096	Looking at POC
	46.0		DSCN_3097	Looking down line
	46.0		DSCN_3098	Up reservoir
	46.0		DSCN_3099	Down reservoir
	19.5		DSCN_3100	Herb Plot
Upland	-5.0	0	DSCN_3102	Down line
	-5.0		DSCN_3103	Tree plot area
	-7.0	2	DSCN_3104	Up line
	-7.0		DSCN_3105	Up line
	-7.0		DSCN_3106	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S9_Tr 709	1.0	0	DSCN_3445	Herb Plot
	2.0		DSCN_3446	Looking at POC
	2.0		DSCN_3447	Looking down line
	2.0		DSCN_3448	Up reservoir
	2.0		DSCN_3449	Down reservoir
	10.0		DSCN_3452	Herb Plot
	11.0		DSCN_3453	Looking at POC
	11.0		DSCN_3454	Looking down line
	11.0		DSCN_3455	Up reservoir
	11.0		DSCN_3456	Down reservoir
	17.0	-2	DSCN_3457	Herb Plot
	18.0		DSCN_3458	Looking at POC
	18.0		DSCN_3459	Looking down line
	18.0		DSCN_3460	Up reservoir
	18.0		DSCN_3461	Down reservoir
	34.0	-4	DSCN_3462	Herb Plot
	35.0		DSCN_3463	Looking at POC
	35.0		DSCN_3464	Looking down line
	35.0		DSCN_3465	Up reservoir
	35.0		DSCN_3466	Down reservoir
	55.0	-6	DSCN_3467	Herb Plot
	56.0		DSCN_3468	Looking at POC
	56.0		DSCN_3469	Looking down line
	56.0		DSCN_3470	Up reservoir
	56.0		DSCN_3471	Down reservoir
	77.0	-8	DSCN_3472	Herb Plot
	78.0		DSCN_3473	Looking at POC
	78.0		DSCN_3474	Looking down line
	78.0		DSCN_3475	Up reservoir
	78.0		DSCN_3476	Down reservoir
	105.0	-10	DSCN_3477	Herb Plot
	106.0		DSCN_3478	Looking at POC
	106.0		DSCN_3479	Looking down line
	106.0		DSCN_3480	Up reservoir
	106.0		DSCN_3481	Down reservoir
	65.0		DSCN_3482	Up line
	41.0		DSCN_3483	Sedge plant
	25.0		DSCN_3484	Sedge plant
	20.0		DSCN_3485	Sedge plant
Upland	6.0	0	DSCN_3440	Up line
	-5.0		DSCN_3438	Upland edge - fir
	-7.0		DSCN_3443	Down/Res side - line
	-7.0	2	DSCN_3441	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S9_Tr 710	0.0	0	DSCN_3398	Herb Plot
	1.0		DSCN_3399	Looking at POC
	1.0		DSCN_3400	Looking down line
	1.0		DSCN_3401	Up reservoir
	1.0		DSCN_3402	Down reservoir
	13.0	-2	DSCN_3403	Herb Plot
	14.0		DSCN_3404	Looking at POC
	14.0		DSCN_3405	Looking down line
	14.0		DSCN_3406	Up reservoir
	14.0		DSCN_3407	Down reservoir
	34.0	-4	DSCN_3409	Herb Plot
	35.0		DSCN_3410	Looking at POC
	35.0		DSCN_3411	Looking down line
	35.0		DSCN_3412	Up reservoir
	35.0		DSCN_3413	Down reservoir
	50.2	-6	DSCN_3414	Herb Plot
	51.2		DSCN_3415	Looking at POC
	51.2		DSCN_3416	Looking down line
	51.2		DSCN_3417	Up reservoir
	51.2		DSCN_3418	Down reservoir
	81.4	-8	DSCN_3420	Herb Plot
	82.4		DSCN_3421	Looking at POC
	82.4		DSCN_3422	Looking down line
	82.4		DSCN_3423	Up reservoir
	82.4		DSCN_3424	Down reservoir
	107.5	-10	DSCN_3425	Herb Plot
	108.5		DSCN_3428	Looking at POC
	108.5		DSCN_3429	Looking down line
	108.5		DSCN_3430	Up reservoir
	108.5		DSCN_3431	Down reservoir
	55.0		DSCN_3432	Herb Plot
	29.0		DSCN_3434	Herb Plot
	5.4		DSCN_3435	Herb Plot
Uplands	0.0	0	DSCN_3392	Down line
	-2.0		DSCN_3393	Down line
	-8.0		DSCN_3394	Down reservoir
	-8.0		DSCN_3395	Up reservoir
	-10.0		DSCN_3396	Up line
	-13.5	2	DSCN_3397	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S9_Tr 711	2.0	0	DSCN_3353	Herb Plot
	3.0		DSCN_3354	Looking at POC
	3.0		DSCN_3355	Looking down line
	3.0		DSCN_3356	Up reservoir
	3.0		DSCN_3357	Down reservoir
	17.0	-2	DSCN_3358	Herb Plot
	18.0		DSCN_3359	Looking at POC
	18.0		DSCN_3360	Looking down line
	18.0		DSCN_3361	Up reservoir
	18.0		DSCN_3362	Down reservoir
	44.0	-4	DSCN_3365	Herb Plot
	45.0		DSCN_3366	Looking at POC
	45.0		DSCN_3367	Looking down line
	45.0		DSCN_3368	Up reservoir
	45.0		DSCN_3369	Down reservoir
	70.2	-6	DSCN_3370	Herb Plot
	71.2		DSCN_3371	Looking at POC
	71.2		DSCN_3372	Looking down line
	71.2		DSCN_3373	Up reservoir
	71.2		DSCN_3374	Down reservoir
	115.5	-8	DSCN_3376	Herb Plot
	116.5		DSCN_3377	Looking at POC
	116.5		DSCN_3378	Looking down line
	116.5		DSCN_3379	Up reservoir
	116.5		DSCN_3380	Down reservoir
	151.0	-10	DSCN_3384	Herb Plot
	152.0		DSCN_3385	Looking at POC
	152.0		DSCN_3386	Looking down line
	152.0		DSCN_3387	Up reservoir
	152.0		DSCN_3388	Down reservoir
	18.3		DSCN_3390	Herb Plot
	20.5		DSCN_3391	Herb Plot
Upland	-8.0	0	DSCN_3348	Down line
	-8.0		DSCN_3349	Up line
	-8.0		DSCN_3350	Down reservoir
	-12.0		DSCN_3351	Up line
	-14.0	2	DSCN_3352	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S9_Tr 712	1.0	0	DSCN_3300	H Plot
	2.0		DSCN_3301	Looking at POC
	2.0		DSCN_3302	Looking down line
	2.0		DSCN_3303	Up reservoir
	2.0		DSCN_3304	Down reservoir
	18.0	-2	DSCN_3307	H Plot
	19.0		DSCN_3308	Looking at POC
	19.0		DSCN_3309	Looking down line
	19.0		DSCN_3310	Up reservoir
	19.0		DSCN_3311	Down reservoir
	32.0	-4	DSCN_3313	H Plot
	39.0		DSCN_3314	Looking at POC
	39.0		DSCN_3315	Looking down line
	39.0		DSCN_3316	Up reservoir
	39.0		DSCN_3317	Down reservoir
	51.0		DSCN_3318	H Plot
	52.0		DSCN_3319	Looking at POC
	52.0		DSCN_3320	Looking down line
	52.0		DSCN_3321	Up reservoir
	52.0		DSCN_3322	Down reservoir
	70.2	-6	DSCN_3323	H Plot
	71.0		DSCN_3324	Looking at POC
	71.0		DSCN_3325	Looking down line
	71.0		DSCN_3326	Up reservoir
	71.0		DSCN_3327	Down reservoir
	125.0	-8	DSCN_3329	H Plot
	126.0		DSCN_3330	Looking at POC
	126.0		DSCN_3331	Looking down line
	126.0		DSCN_3332	Up reservoir
	126.0		DSCN_3333	Down reservoir
	168.2	-10	DSCN_3334	H Plot
	129.0		DSCN_3335	Looking at POC
	129.0		DSCN_3336	Looking down line
	129.0		DSCN_3337	Up reservoir
	129.0		DSCN_3338	Down reservoir
Upland	-1.0	0	DSCN_3341	Down line
	-4.0		DSCN_3342	Down line
	-4.0		DSCN_3343	Up line
	-8.0		DSCN_3344	Down line
	-8.0		DSCN_3345	Up line
	-13.0	2	DSCN_3347	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S10_Tr 714	0.0	0	DSCN_3159	Herb Plot
	1.0		DSCN_3160	Looking at POC
	1.0		DSCN_3161	Looking down line
	1.0		DSCN_3162	Up reservoir
	1.0		DSCN_3163	Down reservoir
	15.0	-2	DSCN_3164	Herb Plot
	16.0		DSCN_3165	Looking at POC
	16.0		DSCN_3166	Looking down line
	16.0		DSCN_3167	Up reservoir
	16.0		DSCN_3168	Down reservoir
	35.6	-4	DSCN_3169	Herb Plot
	36.6		DSCN_3170	Looking at POC
	36.6		DSCN_3171	Looking down line
	36.6		DSCN_3172	Up reservoir
	36.6		DSCN_3173	Down reservoir
	52.5	-6	DSCN_3182	Herb Plot
	53.5		DSCN_3183	Looking at POC
	53.5		DSCN_3184	Looking down line
	53.5		DSCN_3185	Up reservoir
	53.5		DSCN_3186	Down reservoir
	68.8	-8	DSCN_3187	Herb Plot
	69.8		DSCN_3188	Looking at POC
	69.8		DSCN_3189	Looking down line
	69.8		DSCN_3190	Up reservoir
	69.8		DSCN_3191	Down reservoir
	83.7	-10	DSCN_3197	Herb Plot
	84.7		DSCN_3198	Looking at POC
	84.7		DSCN_3199	Looking down line
	84.7		DSCN_3200	Up reservoir
	84.7		DSCN_3201	Down reservoir
	42.7		DSCN_3202	Herb Plot
	26.6		DSCN_3206	Herb Plot
	7.3		DSCN_3208	Herb Plot
Upland	-2.0	0	DSCN_3174	Down line
	-8.0		DSCN_3176	Down line
	-8.0		DSCN_3179	Up line
	-11.0	2	DSCN_3180	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S10_Tr713	1.0	0	DSCN_3215	Herb Plot
	2.0		DSCN_3216	Looking at POC
	2.0		DSCN_3217	Looking down line
	2.0		DSCN_3218	Up reservoir
	2.0		DSCN_3219	Down reservoir
	11.0	-2	DSCN_3222	Herb Plot
	12.0		DSCN_3228	Looking at POC
	12.0		DSCN_3225	Looking down line
	12.0		DSCN_3226	Up reservoir
	12.0		DSCN_3227	Down reservoir
	25.0	-4	DSCN_3230	Herb Plot
	26.0		DSCN_3231	Looking at POC
	26.0		DSCN_3232	Looking down line
	26.0		DSCN_3233	Up reservoir
	26.0		DSCN_3234	Down reservoir
	51.0	-6	DSCN_3238	Herb Plot
	52.0		DSCN_3240	Looking at POC
	52.0		DSCN_3241	Looking down line
	52.0		DSCN_3242	Up reservoir
	52.0		DSCN_3243	Down reservoir
	70.2	-8	DSCN_3244	Herb Plot
	71.2		DSCN_3245	Looking at POC
	71.2		DSCN_3246	Looking down line
	71.2		DSCN_3247	Up reservoir
	71.2		DSCN_3248	Down reservoir
	83.6	-10	DSCN_3249	Herb Plot
	84.6		DSCN_3250	Looking at POC
	84.6		DSCN_3251	Looking down line
	84.6		DSCN_3252	Up reservoir
	84.6		DSCN_3253	Down reservoir
	27.0		DSCN_3235	Herb Plot
	47.0		DSCN_3254	Herb Plot
	19.6		DSCN_3255	Herb Plot
Upland	-1.0	0	DSCN_3209	Down line
	-4.0		DSCN_3210	Up line
	-4.0		DSCN_3211	Down line
	-8.0		DSCN_3212	Up line
	-14.0	2	DSCN_3213	EOT

Date: June 11, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S10_Tr6	2.0	0	DSCN_3256	Herb Plot
	3.0		DSCN_3257	Looking at POC
	3.0		DSCN_3258	Looking down line
	3.0		DSCN_3259	Up reservoir
	3.0		DSCN_3260	Down reservoir
	17.0	-2	DSCN_3262	Herb Plot
	18.0		DSCN_3263	Looking at POC
	18.0		DSCN_3264	Looking down line
	18.0		DSCN_3265	Up reservoir
	18.0		DSCN_3266	Down reservoir
	44.0	-4	DSCN_3267	Herb Plot
	45.0		DSCN_3268	Looking at POC
	45.0		DSCN_3269	Looking down line
	45.0		DSCN_3270	Up reservoir
	45.0		DSCN_3271	Down reservoir
	70.0	-6	DSCN_3272	Herb Plot
	71.0		DSCN_3273	Looking at POC
	71.0		DSCN_3274	Looking down line
	71.0		DSCN_3275	Up reservoir
	71.0		DSCN_3276	Down reservoir
	100.0	-8	DSCN_3277	Herb Plot
	101.0		DSCN_3278	Looking at POC
	101.0		DSCN_3279	Looking down line
	101.0		DSCN_3280	Up reservoir
	101.0		DSCN_3281	Down reservoir
	150.0	-10	DSCN_3282	Herb Plot
	151.0		DSCN_3283	Looking at POC
	151.0		DSCN_3284	Looking down line
	151.0		DSCN_3285	Up reservoir
	151.0		DSCN_3286	Down reservoir
	131.0		DSCN_3287	Herb Plot
	3.6		DSCN_3289	Herb Plot
Upland	-1.0	0	DSCN_3290	Down line
	-1.0		DSCN_3291	Down reservoir
	-5.0		DSCN_3292	Down line
	-10.0		DSCN_3293	Down line
	-10.0		DSCN_3294	Up reservoir
	-10.0		DSCN_3296	Up line
	-24.0	2	DSCN_3295	EOT
	-13.0		DSCN_3299	Erosion from the creek

Date: June 12, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S11_TR715	0.0	0	DSCN_3624	Herb Plot
	1.0		DSCN_3625	Looking at POC
	1.0		DSCN_3626	Looking down line
	1.0		DSCN_3627	Up reservoir
	1.0		DSCN_3628	Down reservoir
	13.0	-2	DSCN_3629	Herb Plot
	14.0		DSCN_3630	Looking at POC
	14.0		DSCN_3631	Looking down line
	14.0		DSCN_3632	Up reservoir
	14.0		DSCN_3633	Down reservoir
	26.0	-4	DSCN_3634	Herb Plot
	27.0		DSCN_3635	Looking at POC
	27.0		DSCN_3636	Looking down line
	27.0		DSCN_3637	Up reservoir
	27.0		DSCN_3638	Down reservoir
	38.0	-6	DSCN_3644	Herb Plot
	39.0		DSCN_3645	Looking at POC
	39.0		DSCN_3646	Looking down line
	39.0		DSCN_3647	Up reservoir
	39.0		DSCN_3648	Down reservoir
	58.0	-8	DSCN_3639	Herb Plot
	59.0		DSCN_3640	Looking at POC
	59.0		DSCN_3641	Looking down line
	59.0		DSCN_3642	Up reservoir
	59.0		DSCN_3643	Down reservoir
	72.0	-10	DSCN_3649	Herb Plot
	73.0		DSCN_3650	Looking at POC
	73.0		DSCN_3651	Looking down line
	73.0		DSCN_3652	Up reservoir
	73.0		DSCN_3653	Down reservoir
Upland	-2.0	0	DSCN_3654	Down line
	-2.0		DSCN_3655	Up line
	-8.0		DSCN_3656	Down line
	-8.0		DSCN_3657	Up line
	-7.0	2	DSCN_3658	EOT

Date: June 12, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S11_TR716	0.0	0	DSCN_3599	Herb Plot
	1.0		DSCN_3600	Looking at POC
	1.0		DSCN_3601	Looking down line
	1.0		DSCN_3602	Up reservoir
	1.0		DSCN_3603	Down reservoir
	13.0	-2	DSCN_3604	Herb Plot
	14.0		DSCN_3605	Looking at POC
	14.0		DSCN_3606	Looking down line
	14.0		DSCN_3607	Up reservoir
	14.0		DSCN_3608	Down reservoir
	26.0	-4	DSCN_3609	Herb Plot
	27.0		DSCN_3610	Looking at POC
	27.0		DSCN_3611	Looking down line
	27.0		DSCN_3612	Up reservoir
	27.0		DSCN_3613	Down reservoir
	41.8	-6	DSCN_3614	Herb Plot
	42.8		DSCN_3615	Looking at POC
	42.8		DSCN_3616	Looking down line
	42.8		DSCN_3617	Up reservoir
	42.8		DSCN_3618	Down reservoir
	56.8	-8	creek	Transect line in the creek
	57.8		creek	Transect line in the creek
	57.8		creek	Transect line in the creek
	57.8		creek	Transect line in the creek
	57.8		creek	Transect line in the creek
	71.0	-10	creek	Transect line in the creek
	72.0		creek	Transect line in the creek
	72.0		creek	Transect line in the creek
	72.0		creek	Transect line in the creek
	72.0		creek	Transect line in the creek
			DSCN_3659	Looking at creek that ran through the transect line
			DSCN_3660	Looking at creek that ran through the transect line
			DSCN_3661	Looking at creek that ran through the transect line
Upland	-1.0	0	DSCN_3619	Down line
	-1.0		DSCN_3620	Up line
	-5.0		DSCN_3621	Down line
	-5.0		DSCN_3622	Up line
	-7.0	2	DSCN_3623	EOT

Date: June 12, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S12_TR718	0.0	0	DSCN_3560	Herb Plot
	1.0		DSCN_3561	Looking at POC
	1.0		DSCN_3562	Looking down line
	1.0		DSCN_3563	Up reservoir
	1.0		DSCN_3564	Down reservoir
	9.0	-2	DSCN_3565	Herb Plot
	10.0		DSCN_3566	Looking at POC
	10.0		DSCN_3567	Looking down line
	10.0		DSCN_3568	Up reservoir
	10.0		DSCN_3569	Down reservoir
	19.0	-4	DSCN_3570	Herb Plot
	20.0		DSCN_3571	Looking at POC
	20.0		DSCN_3572	Looking down line
	20.0		DSCN_3573	Up reservoir
	20.0		DSCN_3574	Down reservoir
	27.0	-6	DSCN_3575	Herb Plot
	28.0		DSCN_3576	Looking at POC
	28.0		DSCN_3577	Looking down line
	28.0		DSCN_3578	Up reservoir
	28.0		DSCN_3579	Down reservoir
	43.0	-8	DSCN_3580	Herb Plot
	44.0		DSCN_3581	Looking at POC
	44.0		DSCN_3582	Looking down line
	44.0		DSCN_3583	Up reservoir
	44.0		DSCN_3584	Down reservoir
	52.4	-10	DSCN_3585	Herb Plot
	53.4		DSCN_3586	Looking at POC
	53.4		DSCN_3587	Looking down line
	53.4		DSCN_3588	Up reservoir
	53.4		DSCN_3589	Down reservoir
	6.0		DSCN_3596	Herb Plot
	6.0		DSCN_3597	Down reservoir
	6.0		DSCN_3598	Down reservoir, down line, looking at sedge patch
Upland	-7.0	0	DSCN_3594	Down line-down/res side
	-7.0		DSCN_3591	Up line
	-7.0		DSCN_3595	Down line-up/res side
	-7.0		DSCN_3593	EOT

Date: June 12, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S12_TR5	0.0	0	DSCN_3522	Herb Plot
	1.0		DSCN_3523	Looking at POC
	1.0		DSCN_3524	Looking down line
	1.0		DSCN_3525	Up reservoir
	1.0		DSCN_3526	Down reservoir
	11.0	-2	DSCN_3530	Herb Plot
	12.0		DSCN_3531	Looking at POC
	12.0		DSCN_3532	Looking down line
	12.0		DSCN_3533	Up reservoir
	12.0		DSCN_3534	Down reservoir
	19.0	-4	DSCN_3535	Herb Plot
	20.0		DSCN_3536	Looking at POC
	20.0		DSCN_3537	Looking down line
	20.0		DSCN_3538	Up reservoir
	20.0		DSCN_3539	Down reservoir
	31.0	-6	DSCN_3540	Herb Plot
	32.0		DSCN_3541	Looking at POC
	32.0		DSCN_3542	Looking down line
	32.0		DSCN_3543	Up reservoir
	32.0		DSCN_3544	Down reservoir
	44.0	-8	DSCN_3545	Herb Plot
	45.0		DSCN_3546	Looking at POC
	45.0		DSCN_3547	Looking down line
	45.0		DSCN_3548	Up reservoir
	45.0		DSCN_3549	Down reservoir
	58.0	-10	DSCN_3550	Herb Plot
	59.0		DSCN_3551	Looking at POC
	59.0		DSCN_3552	Looking down line
	59.0		DSCN_3553	Up reservoir
	59.0		DSCN_3554	Down reservoir
Upland	-4.0	0	DSCN_3555	Down line
	-4.0		DSCN_3556	Up line
	-12.0		DSCN_3557	Down line- up/res side
	-12.0		DSCN_3558	Up line
	-12.0	2	DSCN_3559	EOT

Date: June 13, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S13_Tr717	0.0	0	DSCN_3796	Herb Plot DSCN_3793,3794,3795)
	1.0		DSCN_3798	Looking at POC
	1.0		DSCN_3799	Looking down line
	1.0		DSCN_3800	Up reservoir
	1.0		DSCN_3801	Down reservoir
	14.0		DSCN_3807	Herb Plot
	15.0		DSCN_3808	Looking at POC
	15.0		DSCN_3809	Looking down line
	15.0		DSCN_3810	Up reservoir
	15.0		DSCN_3811	Down reservoir
	31.0	-2	DSCN_3812	Herb Plot (DSCN_3813)
	32.0		DSCN_3814	Looking at POC
	32.0		DSCN_3815	Looking down line
	32.0		DSCN_3816	Up reservoir
	32.0		DSCN_3817	Down reservoir
	40.0		DSCN_3818	Herb Plot
	41.0		DSCN_3819	Looking at POC
	41.0		DSCN_3820	Looking down line
	41.0		DSCN_3821	Up reservoir
	41.0		DSCN_3822	Down reservoir
	48.0	-3	DSCN_3823	Herb Plot
	49.0		DSCN_3824	Looking at POC
	49.0		DSCN_3825	Looking down line
	49.0		DSCN_3826	Up reservoir
	49.0		DSCN_3827	Down reservoir
	53.0		DSCN_3828	Herb Plot
	54.0		DSCN_3830	Looking at POC
	54.0		DSCN_3831	Looking down line
	54.0		DSCN_3832	Up reservoir
	54.0		DSCN_3833	Down reservoir
	100.0		DSCN_3834	Herb Plot
	101.0		DSCN_3835	Looking at POC
	101.0		DSCN_3836	Looking down line
	101.0		DSCN_3837	Up reservoir
	101.0		DSCN_3838	Down reservoir
Upland	-1.0	0	DSCN_3803	At POC - tree plot
	-1.0		DSCN_3804	Down reservoir side - tree plot
	-1.0		DSCN_3805	Up reservoir side - tree plot
	-1.0		DSCN_3806	Up reservoir
	-10.0		DSCN_3802	EOT - not at 2m, change in elevation

Date: June 13, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S13_Tr4	0.0	0	DSCN_3734	Herb Plot (DSCN_3733)
	1.0		DSCN_3735	Looking at POC
	1.0		DSCN_3740	Looking down line
	1.0		DSCN_3738	Up reservoir
	1.0		DSCN_3739	Down reservoir
	23.0	-1	DSCN_3742	Herb Plot (DSCN_3741)
	24.0		DSCN_3744	Looking at POC
	24.0		DSCN_3743	Looking down line
	24.0		DSCN_3745	Up reservoir
	24.0		DSCN_3746	Down reservoir
	40.0		DSCN_3747	Herb Plot
	41.0		DSCN_3748	Looking at POC
	41.0		DSCN_3749	Looking down line
	41.0		DSCN_3750	Up reservoir
	41.0		DSCN_3751	Down reservoir
	46.0	-2	DSCN_3752	Herb Plot (DSCN_3753)
	47.0		DSCN_3754	Looking at POC
	47.0		DSCN_3755	Looking down line
	47.0		DSCN_3756	Up reservoir
	47.0		DSCN_3757	Down reservoir
	65.0	-3	DSCN_3759	Herb Plot (DSCN_3758)
	66.0		DSCN_3760	Looking at POC
	66.0		DSCN_3761	Looking down line
	66.0		DSCN_3762	Up reservoir
	66.0		DSCN_3763	Down reservoir
	99.0		DSCN_3766	Herb Plot (DSCN_3764,3765)
	100.0		DSCN_3767	Looking at POC
	100.0		DSCN_3768	Looking down line
	100.0		DSCN_3769	Up reservoir
	100.0		DSCN_3770	Down reservoir
	77.0		DSCN_3772	Herb Plot (DSCN_3771)
	72.0		DSCN_3773	Herb Plot
Upland	-10.0	0	DSCN_3787	Up line
	-10.0		DSCN_3788	Down reservoir
	-10.0		DSCN_3789	Up reservoir
	-13.0		DSCN_3790	Down line
	-13.0		DSCN_3791	Down reservoir
	-13.0		DSCN_3792	EOT - not at 2m, change in elevation

Date: June 13, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S13_Tr719	0.0	0	DSCN_3839	Herb Plot
	1.0		DSCN_3841	Looking at POC
	1.0		DSCN_3842	Looking down line
	1.0		DSCN_3843	Up reservoir
	1.0		DSCN_3844	Down reservoir
	35.0	-2	DSCN_3845	Herb Plot
	36.0		DSCN_3846	Looking at POC
	36.0		DSCN_3847	Looking down line
	36.0		DSCN_3848	Up reservoir
	36.0		DSCN_3849	Down reservoir
	54.0	-3	DSCN_3850	Herb Plot
	56.0		DSCN_3851	Looking at POC
	56.0		DSCN_3852	Looking down line
	56.0		DSCN_3853	Up reservoir
	56.0		DSCN_3854	Down reservoir
	70.0	-4	DSCN_3856	Herb Plot
	71.0		DSCN_3857	Looking at POC
	71.0		DSCN_3858	Looking down line
	71.0		DSCN_3859	Up reservoir
	71.0		DSCN_3860	Down reservoir
	82.0		DSCN_3862	Herb Plot
	83.0		DSCN_3863	Looking at POC
	83.0		DSCN_3864	Looking down line
	83.0		DSCN_3865	Up reservoir
	83.0		DSCN_3866	Down reservoir
	89.0		DSCN_3867	Herb Plot
	90.0		DSCN_3868	Looking at POC
	90.0		DSCN_3869	Looking down line
	90.0		DSCN_3870	Up reservoir
	90.0		DSCN_3871	Down reservoir
	100.0	-5	DSCN_3873	Herb Plot
	101.0		DSCN_3874	Looking at POC
	101.0		DSCN_3875	Looking down line
	101.0		DSCN_3876	Up reservoir
	101.0		DSCN_3877	Down reservoir
Upland	-5.0	0	DSCN_3878	Up line
	-5.0		DSCN_3879	Down line
	-5.0		DSCN_3880	Down reservoir
	-5.0		DSCN_3881	Up reservoir
	-20.0		DSCN_3882	Up line
	-20.0		DSCN_3883	Down line
	-20.0		DSCN_3884	Down reservoir
	-20.0		DSCN_3885	Up reservoir
	-20.0		DSCN_3886	EOT - not at 2m, change in elevation

Date: June 13, 2015		**Project Leader:** Mary Louise Polzin		
Location: Duncan Reservoir			**Field Crew:** Ben Meunier, Jessica Romeo, Mary Louise Polzin	
S_TR#	**Metre Mark**	**Elevation**	**Image #**	**Description**
S13_Tr720	0.0	0	DSCN_3899	Herb Plot
	1.0		DSCN_3900	Looking at POC
	1.0		DSCN_3901	Looking down line
	1.0		DSCN_3902	Up reservoir
	1.0		DSCN_3903	Down reservoir
	20.0	-2	DSCN_3915	Herb Plot
	21.0		DSCN_3916	Looking at POC
	21.0		DSCN_3917	Looking down line
	21.0		DSCN_3918	Up reservoir
	21.0		DSCN_3919	Down reservoir
	33.0	-3	DSCN_3926	Herb Plot
	34.0		DSCN_3927	Looking at POC
	34.0		DSCN_3928	Looking down line
	34.0		DSCN_3929	Up reservoir
	34.0		DSCN_3930	Down reservoir
	54.0	-4	DSCN_3938	Herb Plot
	55.0		DSCN_3939	Looking at POC
	55.0		DSCN_3940	Looking down line
	55.0		DSCN_3942	Up reservoir
	55.0		DSCN_3946	Down reservoir
	85.0		DSCN_3947	Herb Plot
	86.0		DSCN_3948	Looking at POC
	86.0		DSCN_3949	Looking down line
	86.0		DSCN_3950	Up reservoir
	86.0		DSCN_3951	Down reservoir
EOT/12	90.0		DSCN_3953	Herb Plot
Creek	91.0		DSCN_3954	Looking at POC
	91.0		DSCN_3955	Looking down line
	91.0		DSCN_3956	Up reservoir
	91.0		DSCN_3957	Down reservoir
EOT/09	100.0		DSCN_3964	Herb Plot
	101.0		DSCN_3965	Looking at POC
	101.0		DSCN_3966	Looking down line
	101.0		DSCN_3968	Up reservoir
	101.0		DSCN_3967	Down reservoir
Upland	-1.0	0	DSCN_3905	At POC - tree plot
	-1.0		DSCN_3906	Down Reservoir side - tree plot
	-1.0		DSCN_3907	Up Reservoir side - tree plot
	-1.0		DSCN_3908	Up reservoir
	-10.0		DSCN_3909	Up line
	-10.0		DSCN_3910	Down line
	-10.0		DSCN_3911	Down reservoir
	-10.0		DSCN_3912	Up reservoir
	-10.0		DSCN_3913	EOT - not at 2m, change in elevation

Appendix 6: Photograph Contact Sheets

Duncan Reservoir 2015_Site 1 Transect 1


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Duncan Reservoir 2015_Site 1 Transect 1


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Duncan Reservoir 2015_Site 1 Transect 869


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Duncan Reservoir 2015_Site 1 Transect 869


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Duncan Reservoir 2015_Site 1 Transect 869

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DUncan Reservoir 2015_Site 2 Transect 822


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DUncan Reservoir 2015_Site 2 Transect 822


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DUncan Reservoir 2015_Site 2 Transect 822

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Duncan Reservoir 2015_Site 2 Transect 884


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Duncan Reservoir 2015_Site 2 Transect 884


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Duncan Reservoir 2015_Site 2 Transect 884


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DUncan Reservoir 2015_Site 2 Transect 885


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DUncan Reservoir 2015_Site 2 Transect 885


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DUncan Reservoir 2015_Site 3 Transect 812


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DUncan Reservoir 2015_Site 3 Transect 812


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DUncan Reservoir 2015_Site 3 Transect 704


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DUncan Reservoir 2015_Site 3 Transect 704


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Duncan Reservoir 2015_Site4 Transect 705


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Duncan Reservoir 2015_Site4 Transect 705


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Duncan Reservoir 2015_Site4 Transect 706


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Duncan Reservoir 2015_Site4 Transect 706


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Duncan Reservoir 2015_Site4 Transect 706

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Duncan Reservoir 2015_Site 5 Transect 707


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Duncan Reservoir 2015_Site 5 Transect 707


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Duncan Reservoir 2015_Site 5 Transect 813


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Duncan Reservoir 2015_Site 5 Transect 813


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Duncan Reservoir 2015_Site 6 Transect 708


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Duncan Reservoir 2015_Site 6 Transect 708


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Duncan Reservoir 2015_Site 6 Transect 814


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Duncan Reservoir 2015_Site 6 Transect 814


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Duncan Reservoir 2015_Site 7 Transect 2


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Duncan Reservoir 2015_Site 7 Transect 2


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Duncan Reservoir 2015_Site 7 Transect 3


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Duncan Reservoir 2015_Site 7 Transect 3


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Duncan Reservoir 2015_Site 9 Transect 709


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Duncan Reservoir 2015_Site 9 Transect 709


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Duncan Reservoir 2015_Site 9 Transect 709


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Duncan Reservoir 2015_Site 9 Transect 710


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Duncan Reservoir 2015_Site 9 Transect 710


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Duncan Reservoir 2015_Site 9 Transect 711


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Duncan Reservoir 2015_Site 9 Transect 711


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Duncan Reservoir 2015_Site 9 Transect 712


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Duncan Reservoir 2015_Site 9 Transect 712


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Duncan Reservoir 2015_Site 9 Transect 712

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Duncan Reservoir 2015_Site 10 Transect 6


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Duncan Reservoir 2015_Site 10 Transect 6


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Duncan Reservoir 2015_Site 10 Transect 713


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Duncan Reservoir 2015_Site 10 Transect 713


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Duncan Reservoir 2015_Site 10 Transect 714


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Duncan Reservoir 2015_Site 10 Transect 714


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Duncan Reservoir 2015_Site 11 Transect 715


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Duncan Reservoir 2015_Site 11 Transect 715


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Duncan Reservoir 2015_Site 11 Transect 716


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Duncan Reservoir 2015_Site 11 Transect 716


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Duncan Reservoir 2015_Site 12 Transect 5


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Duncan Reservoir 2015_Site 12 Transect 5


DSCN3545


DSCN3546


DSCN3547


DSCN3548


DSCN3549


DSCN3550


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DSCN3557


DSCN3558


DSCN3559

Duncan Reservoir 2015_Site 12 Transect 718


DSCN3560


DSCN3561


DSCN3562


DSCN3563


DSCN3564


DSCN3565


DSCN3566


DSCN3567


DSCN3568


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Duncan Reservoir 2015_Site 12 Transect 718


DSCN3580


DSCN3581


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DSCN3586


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DSCN3594


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DSCN3596


DSCN3597


DSCN3598

DUncan Reservoir 2015_Site 13 Transect 4


DSCN3733


DSCN3734


DSCN3735


DSCN3738


DSCN3739


DSCN3740


DSCN3742


DSCN3743


DSCN3744


DSCN3745


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DSCN3747


DSCN3748


DSCN3749


DSCN3750


DSCN3751


DSCN3752


DSCN3754


DSCN3755


DSCN3756

DUncan Reservoir 2015_Site 13 Transect 4


DSCN3757


DSCN3759


DSCN3760


DSCN3761


DSCN3762


DSCN3763


DSCN3766


DSCN3767


DSCN3768


DSCN3769


DSCN3770


DSCN3772


DSCN3773


DSCN3787


DSCN3788


DSCN3789


DSCN3790


DSCN3791


DSCN3792

DUncan Reservoir 2015_Site 13 Transect 717


DSCN3796


DSCN3798


DSCN3799


DSCN3800


DSCN3801


DSCN3802


DSCN3803


DSCN3804


DSCN3805


DSCN3806


DSCN3807


DSCN3808


DSCN3809


DSCN3810


DSCN3811


DSCN3812


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DSCN3815


DSCN3816


DSCN3817

DUncan Reservoir 2015_Site 13 Transect 717


DSCN3818


DSCN3819


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DSCN3838

Duncan Reservoir 2015_Site 13 Transect 719


DSCN3839


DSCN3841


DSCN3842


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Duncan Reservoir 2015_Site 13 Transect 719


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DSCN3880


DSCN3881


DSCN3882

Duncan Reservoir 2015_Site 13 Transect 719


DSCN3883


DSCN3884


DSCN3885


DSCN3886

Duncan Reservoir 2015_Site 13 Transect 720


DSCN3899


DSCN3900


DSCN3901


DSCN3902


DSCN3903


DSCN3905


DSCN3906


DSCN3907


DSCN3908


DSCN3909


DSCN3910


DSCN3911


DSCN3912


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DSCN3915


DSCN3916


DSCN3917


DSCN3918


DSCN3919


DSCN3926

Duncan Reservoir 2015_Site 13 Transect 720


DSCN3927


DSCN3928


DSCN3929


DSCN3930


DSCN3938


DSCN3939


DSCN3940


DSCN3942


DSCN3946


DSCN3947


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DSCN3949


DSCN3950


DSCN3951


DSCN3953


DSCN3954


DSCN3955


DSCN3956


DSCN3957


DSCN3964

Duncan Reservoir 2015_Site 13 Transect 720


DSCN3965


DSCN3966


DSCN3967


DSCN3968

Appendix 7: GIS Data Submission (digital)