DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof. Reference herein to any social initiative (including but not limited to Diversity, Equity, and Inclusion (DEI); Community Benefits Plans (CBP); Justice 40; etc.) is made by the Author independent of any current requirement by the United States Government and does not constitute or imply endorsement, recommendation, or support by the United States Government or any agency thereof.

HNF-56799
Revision 0

Hanford Site Rare Plant Monitoring Report for Calendar Year 2013

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-09RL14728

P.O. Box 650
Richland, Washington 99352

TRADEMARK DISCLAIMER

This report has been reproduced from the best available copy.

Printed in the United States of America

The cover photo of *Lipocarpha aristulata* is courtesy of M. R. Sackschewsky

HNF-56799
Revision 0

Hanford Site Rare Plant Monitoring Report for Calendar Year 2013

M. Sackschewsky, C. Lindsey, J. Nugent, D. Salstrom, and R. Easterly
Mission Support Alliance

Date Published
February 2014

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-09RL14728

P.O. Box 650
Richland, Washington 99352

APPROVED
By Janis D. Aardal at 11:42 am, Feb 19, 2014

Release Approval Date

Contents

Figures

Tables

1.0 Introduction

The U.S. Department of Energy, Richland Operations Office (DOE-RL) conducts ecological monitoring on the Hanford Site to collect and track data needed to ensure compliance with an array of environmental laws, regulations, and policies governing DOE activities. Ecological monitoring data provide baseline information about the plants, animals, and habitat under DOE-RL stewardship at Hanford required for decision-making under the National Environmental Policy Act (NEPA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Hanford Site Comprehensive Land Use Plan (CLUP, DOE/EIS-0222-F) which is the Environmental Impact Statement for Hanford Site activities, helps ensure that DOE-RL, its contractors, and other entities conducting activities on the Hanford Site are in compliance with NEPA.

The Hanford Site Biological Resources Management Plan (BRMP, DOE/RL 96-32 Rev 1) is identified by the CLUP as the primary implementation control for managing and protecting natural resources on the Hanford Site. According to the CLUP, the BRMP

> *"provides a mechanism for ensuring compliance with laws protecting biological resources; provides a framework for ensuring that appropriate biological resource goals, objectives, and tools are in place to make DOE an effective steward of the Hanford biological resources; and implements an ecosystem management approach for biological resources on the Site. The BRMP provides a comprehensive direction that specifies DOE biological resource policies, goals, and objectives."*

DOE-RL places priority on monitoring those plant and animal species or habitats with specific regulatory protections or requirements; or that are rare and/or declining (federal or state listed endangered, threatened, or sensitive species); or of significant interest to federal, state, or tribal governments or the public. The BRMP ranks wildlife species and habitats (Levels 0-5), providing a graded approach to monitoring biological resources based on the level of concern for each resource. There are at least eight plant species that are listed by the Washington Natural Heritage Program (WNHP) as Endangered, Threatened, Sensitive or review that are known to occur along the shoreline of the Hanford Reach of the Columbia River (Table 1). These species are categorized as Level 4 in the BRMP, requiring a high level of resource monitoring. There are also several rare upland species present on the Hanford Site that qualify as Level 4 resources.

Rare riparian plant species could be affected by waste site remediation work along the river shoreline, by environmental sampling activities, and by maintenance of Hanford Site infrastructure. The Public Safety and Resource Protection Program (PSRP), managed by Mission Support Alliance (MSA), monitors rare plant populations on the Hanford Site to help prevent and minimize Hanford-related impacts to these species, and to monitor for changes in the status or distribution of these plant on the Hanford Site. Monitoring efforts in Calendar Year 2013 were focused on population status assessments of a subset of the known populations of Columbia yellowcress, and spot-surveys for other rare riparian species.

Table 1. Plant Species of Concern Known to Occur in Riparian Areas along the Hanford Reach

Species	Family	Common Name	State Status
Ammannia robusta	Lythraceae	grand redstem	Threatened
Anagallis minimus	Primulaceae	chaffweed	Sensitive
Eleocharis rostellata	Cyperaceae	beaked spikerush	Sensitive
Hypericum majus	Clausiaceae	Canadian St. John wort	Sensitive
Lipocarpha aristulata	Cyperaceae	awned half-chaff sedge	Threatened
Physostegia parviflora	Lamiaceaea	purple dragon-head	Sensitive
Rorippa columbiae	Brassicaceae	Columbia yellowcress	Endangered
Rotala ramosior	Lythraceae	Lowland toothcup	Threatened

2.0 Columbia Yellowcress

2.1 Background

Columbia yellowcress (also known as persistent-sepal yellowcress) (*Rorippa columbiae*) (Figure 1) is a rhizomatous perennial species that occurs along the lower shorelines of the Columbia River on the Hanford Site in south-central Washington State. It is endemic to Washington, Oregon, and California, is a Species of Concern for the USFWS, and is considered to be endangered in Washington (WNHP 2013). Extensive damming of the Columbia River in Washington has eliminated its habitat along much of the shoreline. The species is currently known from two disjunct locations along the Columbia River: a relatively small occurrence below Bonneville Dam and a much larger occurrence on the Hanford Reach, which is the most extensive of any of the species' populations.

Along the Hanford Reach, the species occurs in the open cobble of the lower-most vegetated zone. Populations generally occur where shoreline and channel topography combine to create a surging or accelerating river current (for example, gravel bars that jut into the river flow).

Figure 1. Columbia Yellowcress in Bloom along the Hanford Reach During 2012

Monitoring in 2011 and 2012 was focused on a complete survey for Columbia yellowcress along the DOE-managed portion of the Hanford Site or right bank of the Columbia River (Salstrom et al. 2012, 2013). These surveys identified a total of 245 patches of Columbia yellowcress along about 63 miles (100 km) of river shoreline (Figure 2). Over 91,000 individual ramets were counted at these sites over the two years.

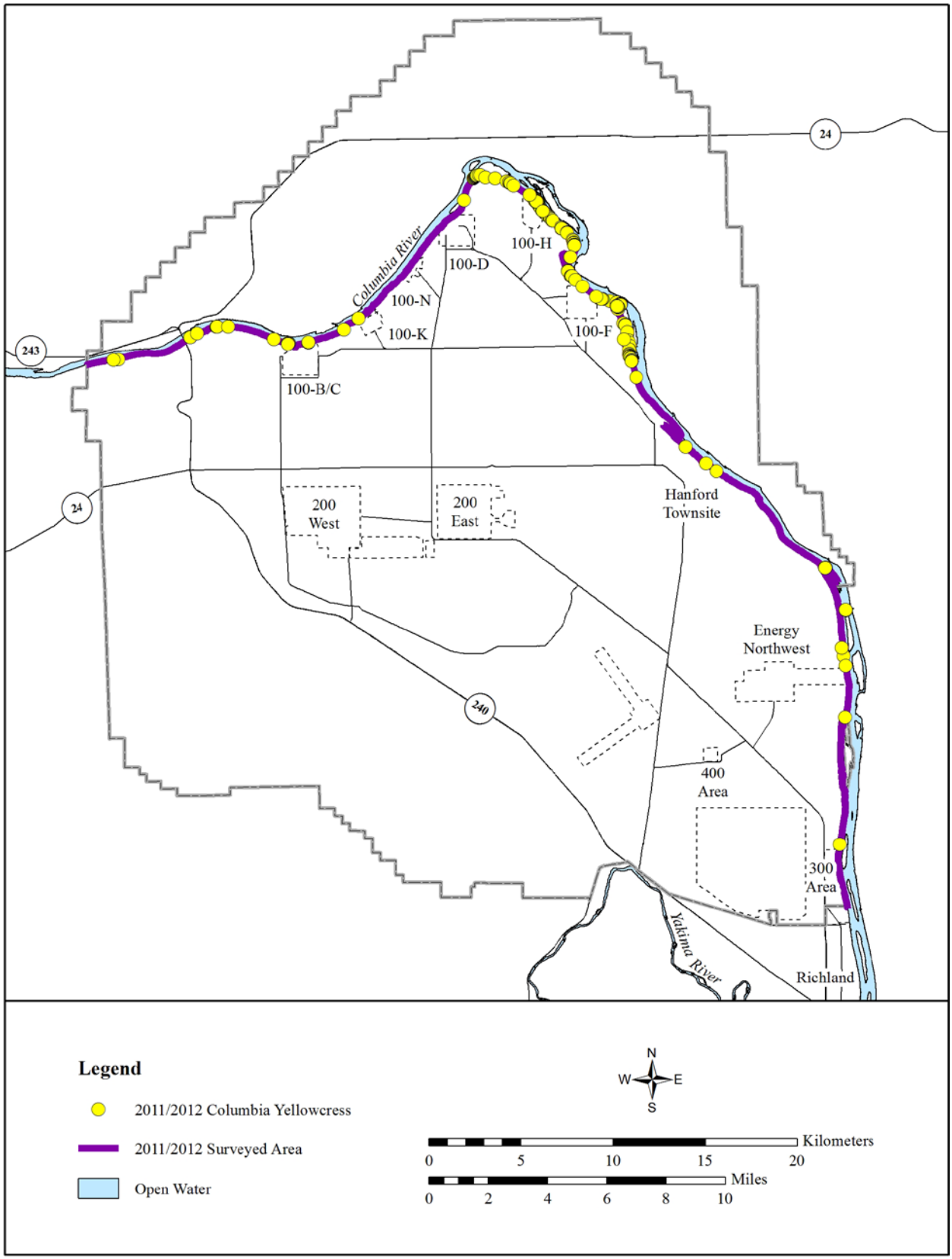

Figure 2. Surveyed Area and Locations for Columbia Yellowcress from the 2011 and 2012 Surveys

2.2 Effects of River Fluctuations

Management of the river flow from upstream dams now regularly inundates the species' habitat on a daily cycle for extended periods during the summer. This has likely shifted the growing season into the late summer and fall when the habitat is more reliably and continuously exposed. More recently, the growing season has been abruptly curtailed in mid-October due to Reverse Load Factoring. Reverse Load Factoring is defined by the Hanford Reach Fall Chinook Protection Program (HRFCPP 2004) as "the intentional reduction of power generation during daylight hours and the corresponding increase in power generation during hours of darkness for the purpose of influencing the location of redds on Vernita Bar, during which the habitat is flooded on a daily cycle to influence placement of redds by fall Chinook salmon" (HRFCPP 2004). This results in low flows during daylight periods and high flows during the night, the "reverse" of a typical flow regime driven by power demand. Due to the shifted and truncated growing season, fruits of Columbia yellowcress seldom have a long enough and/or warm enough season to develop, and mature fruits are now rarely observed under this management strategy.

Photo-documentation of the diurnal inundation due to reverse load factoring was obtained by installing a wildlife trail-camera overlooking one of the larger Columbia yellowcress populations (#404) located near 100-H Area. The camera was set to capture an image every 15 minutes starting well before sunrise until after sunset. Photos were collected between September 26, and November 5, 2013.

Reverse load factoring started on October 15, 2013. On most days prior to that date, the water level remained relatively low all day, or showed only minor mid- to late day fluctuations (Figure 3). However, on four of the twenty days there was a significant mid- to late day rise in river flow that clearly inundated the observed population (Figure 4); there was no clear pattern in the timing of these occurrences. After the start of reverse load factoring the typical daily pattern was very high water levels at dawn that clearly inundated the population, followed by a quick lowering of the water level, so that relatively low, stable water levels were observed from mid-morning until dusk (Figure 5). With the onset of salmon spawning, the river level is kept low on Sundays to allow for redd counts, this was observed in photographs taken on November 3, 2013.

Figure 3. Typical River Flow Pattern for Most Days Between September 26 and October 15, 2013

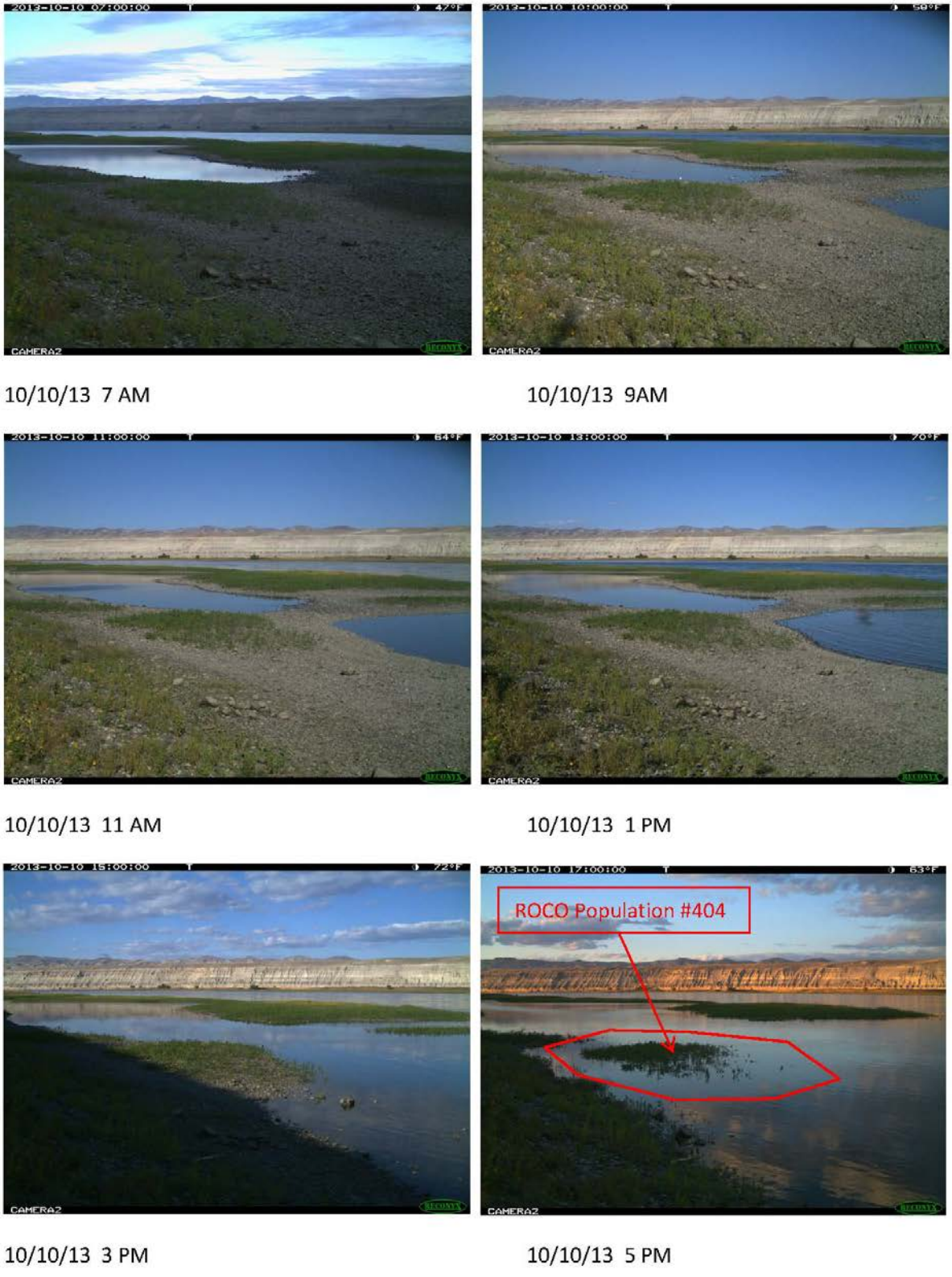

Figure 4. Mid- to Late-day Rise in River Flow Observed Occasionally Before October15, 2013

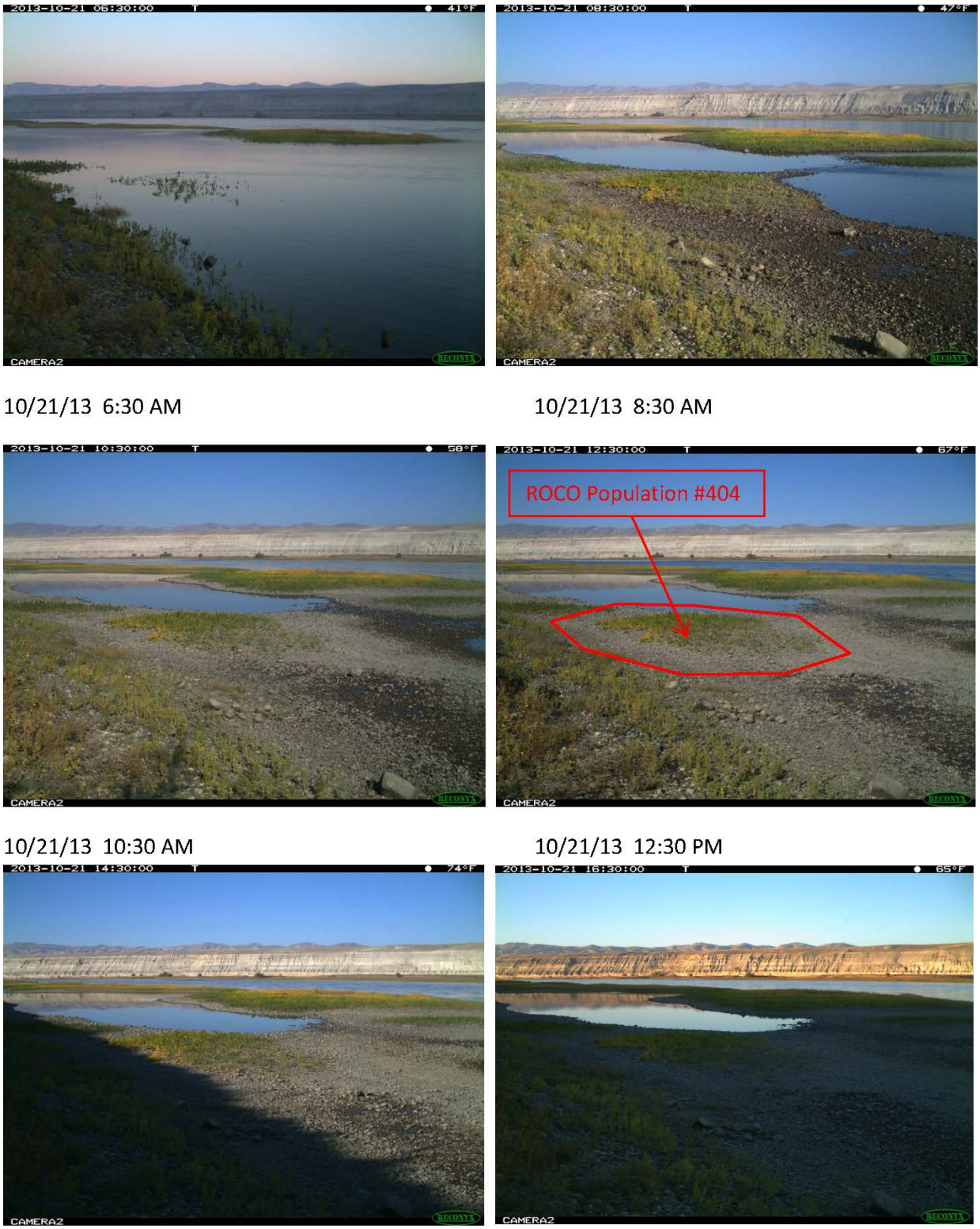

Figure 5. Typical River Flow Pattern with Reverse Load Factoring After October 15, 2013

2.3 Population Changes

The number of ramets (stems) in a population can fluctuate widely from year to year, likely at least partially due to patterns of inundation and temperature during the growing season. Previously, the species had been monitored over several years in plots at several locations on the Hanford Reach, including mid-Reach at Locke Island (Island 6) and 100-F Beach by PNNL and in the lower reach at Homestead (Island 13) and Plow (Island 12) Islands by the Bureau of Land Management (BLM) and the WNHP. Since the beginning of monitoring at Locke Island and 100-F Beach, ramet numbers declined radically, were low for a number of years then gradually increased, but have not reached ramet densities recorded in 1994 (PNNL 2010). The plots at Homestead and Plow islands in the lower Reach have shown a sharp decline in the number of ramets between 1994 and 2002 (Caplow 2003). The most recently reported shoreline survey, apart from at established monitoring plots, was in 2001, when a "precipitous decline" of the species along the Hanford Reach downriver from White Bluffs Boat Launch was reported (Caplow 2003). Salstrom et al. 2013 reported stem density comparisons for two sites that were examined in both 2011 and 2012. At one location the count increased from 40 to 65 within a 15 m^2 area; at the other location the count decreased slightly from 105 to 100 within a 4 m^2 area.

In 2013, 35 previously identified Columbia yellowcress populations were revisited (Figure 6). Populations were located with a GPS point taken at the upstream/inland extent of the patch (or group of patches). The area covered by the population was determined by measuring the length (measured parallel to the direction of flow), and width (measured perpendicular to the direction of flow) of the patch. The number of ramets were counted (or estimated at sites with large numbers), the length of the largest ramet was measured, the ramets with flowers/fruits were counted, and a range of the number of flowers/fruits per ramet was estimated. Photographs were taken to depict habitat characteristics (e.g., density of associated vegetation, cobble size, population locations, and shoreline configuration).

Populations in 2013 ranged from as few as 6 ramets to over 2100 ramets and covered areas from 1 to 200 m^2. The ramet count decreased compared to previous years for most of the populations (Figure 7); no ramets were seen at two populations. However, several populations more than doubled in size. About half of the populations increased in area and half decreased in area covered (Figure 8). Stem density decreased by 25 to 75% for most populations (Figure 9). The decrease in stem count and density may be due to changes in seasonal river flow, differences in temperature patterns over the compared years, or other undetermined factors. For instance, in 2013 there was ten-day period in mid-October when flows were much higher than usual, while the same period in 2012 was lower than normal (Figure 10). Extended lower flows may allow more growth and flowering to occur. Populations of Columbia yellowcress are known to fluctuate widely, thus a one-year decrease in overall stem count is not necessarily significant. However, populations should continue to be monitored annually to identify long-term trends in population size and density. While traveling between selected monitoring sites, six new populations of Columbia yellowcress were discovered, all in the vicinity of 100-H Area (Figure 11). Stem counts and population area measurements, as described above, were collected at these new sites and the populations were added to the site wide-Columbia yellowcress distribution map.

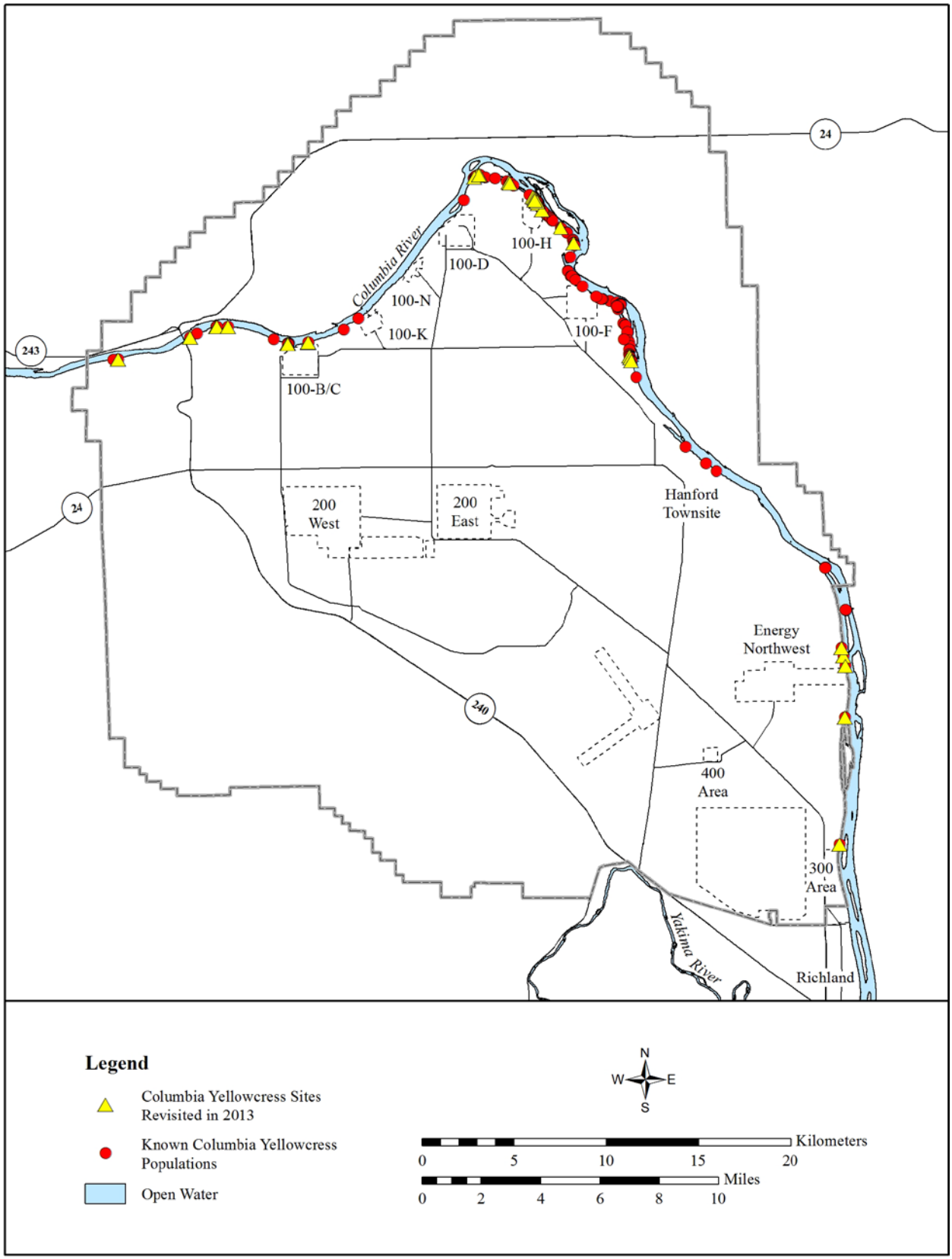

Figure 6. Location of Previously Known Columbia Yellowcress Populations Monitored in 2013

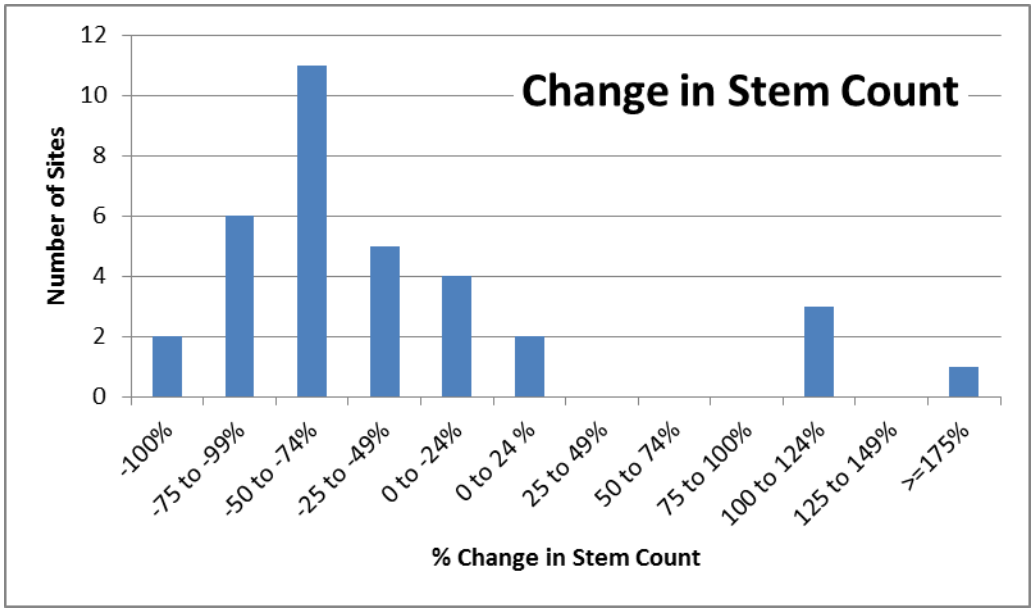

Figure 7. Proportional Change in Columbia Yellowcress Patch Stem Counts in 2013 Compared to 2011 and 2012

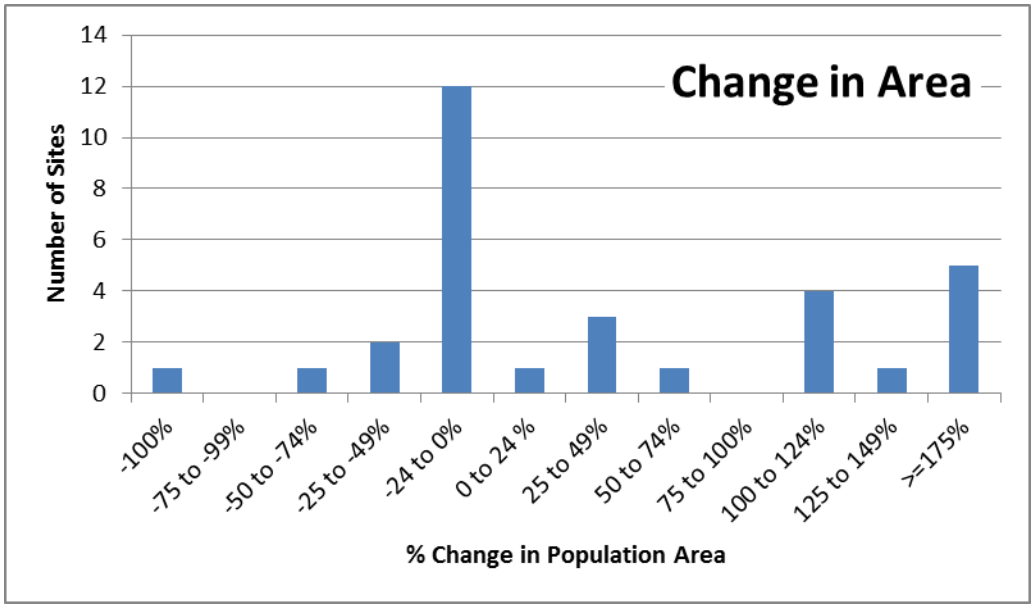

Figure 8. Proportional Change in Area Covered by Columbia Yellowcress Patches in 2013 Compared to 2011 and 2012

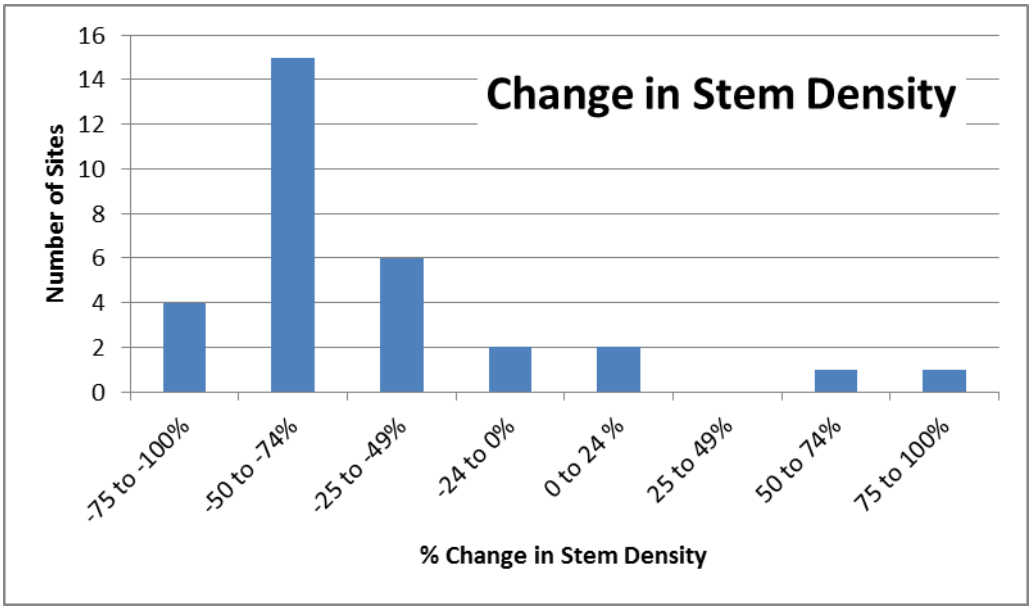

Figure 9. Proportional Change in Stem Density for Columbia Yellowcress Patches in 2013 Compared to 2011 and 2012

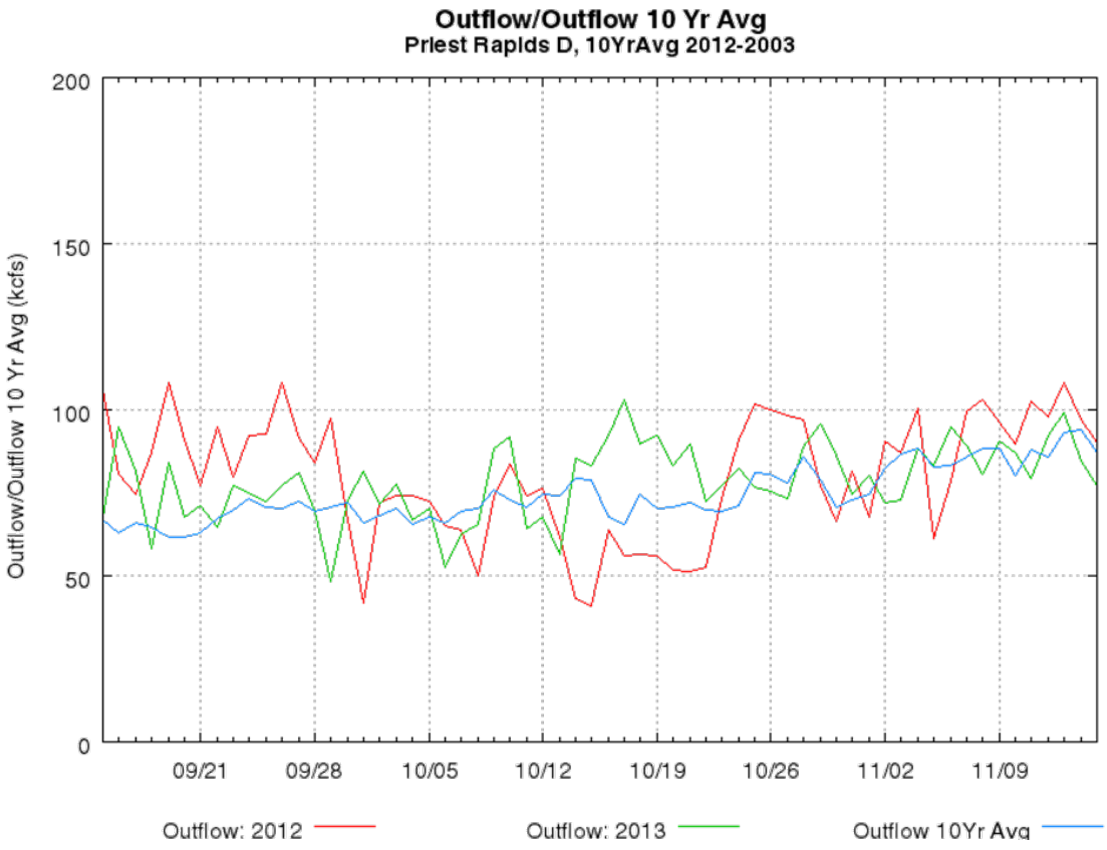

Figure 10. Columbia River Discharge in 2012 and 2013 Compared to the 10-Year Average

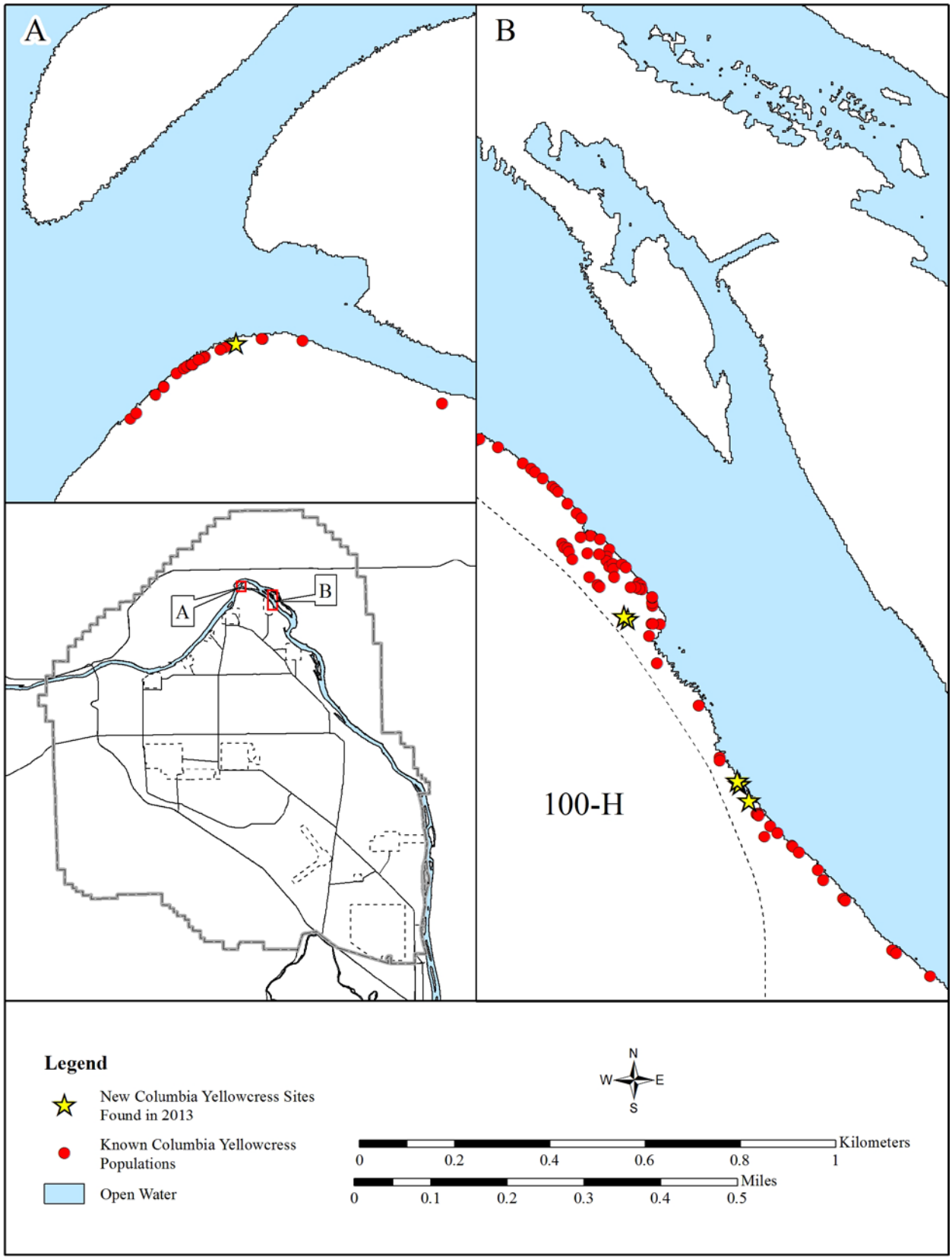

Figure 11. Location of New Columbia Yellowcress Patches Found in 2013

2.4 Discussion

Although Columbia yellowcress continues to occupy areas along the Hanford Reach where its microhabitat requirements exist, and can be relatively abundant during certain years (e.g. 2011 and 2012), its lack of reproduction and recruitment are causes for concern. In 2013, as noted in previous years, the number of ramets with flowers and buds was very low to virtually non-existent, and no mature fruits were observed. The surveys in 2012 and 2013 were conducted late in the growing season, and the absence of mature fruits indicates that the species may not be able to reproduce via seed under the regulated flow conditions present on the Hanford Reach. The habitat is usually inundated until late summer, and even after the average river level drops, it is still periodically submerged by water released during the day for power production by upriver dams. In addition, the habitat is inundated daily beginning in mid-October due to the Reverse Load Factoring flow regime conducted upstream at the Priest Rapids dam. Reverse Load Factoring is used, as part of the Vernita Bar Agreement, to encourage fall Chinook salmon (*Oncorhynchus tshawytscha*) to spawn deeper in the river channel. While the pre-dam river flow regime during summer was characterized by sustained low river levels, current management of the river typically inundates and exposes the species' habitat repeatedly, often daily, during the period when flower and fruit production should occur. Regular inundation reduces the plants ability to photosynthesize, increases the potential for fungal infection, and can result in fine sediments covering the leaves (Figure 12). This management regime has shifted the primary growing period into the fall and has limited, if not halted, reproduction by seed.

Figure 12. Columbia Yellowcress Covered in Sand and Sediment from Frequent Inundation

Long-term trends are often difficult to discern for rhizomatous species such as Columbia yellowcress that produce large fluctuations in the number of ramets from year to year. Annual differences in the river flow patterns and air temperatures during the time the plants are not inundated likely influence the number of ramets and amount of flowering that can occur. Variation in the number of ramets seen year-to-year was noted as early as 1984 (WNHP 2011).

In the lower portion of the Hanford Reach, monitoring data suggest that populations of Columbia yellowcress have declined precipitously since 1994 (Caplow 2003; Salstrom and Easterly personal observation, 2011). The species has not been seen for many years at Ringold, where it had been abundant in the past (William Rickard, personal communication). In contrast, monitoring data collected by PNNL at Locke Island and 100-F-Beach in the mid-portion of the Reach indicated relative stability during recent years, albeit with lower ramet density than recorded during the mid-1990s (PNNL 2010). Those data, together with results of this survey, suggest a possible differential status of the species along the Hanford Reach, with large declines in the lower portions, and apparent relative stability in the middle and upper portions.

The reason(s) for the apparent decline in the lower portions of the Hanford Reach relative to upriver are not understood. One factor may be a 'ripple' effect of inundation that causes an approximately eight-hour lag in inundation/exposure in the lower portions of the Hanford Reach in response to management at Priest Rapids Dam. A result of this delay from one end of the Hanford Reach to another is that, during Reverse Load Factoring, Columbia yellowcress habitat nearer to the dam is exposed near daybreak, while habitat downriver, such as at Homestead and Plow Islands, is typically not exposed until midday, further reducing its growing season in downstream areas.

Other potential contributors may include slumping along the White Bluffs and the entrapment of sediments above upriver dams. Slumping along the White Bluffs may have altered the dynamics of river slope, flow, and subtle downriver trajectories of the river current and subsequent patterns of scour along the shoreline. The microhabitat of Columbia yellowcress along the shoreline appears to be determined by position relative to the current. While it is natural for a river to change course over time, the lack of seed production and the apparent lack of vegetative propagules in Columbia yellowcress suggest that it may not have the means to reestablish itself in newly developed habitat. The entrapment of sediment behind upriver dams essentially eliminates all but local deposits feeding into the Hanford Reach. This may have led to a net-erosion of shoreline material over time, possibly decreasing the overall available habitat.

Future monitoring efforts may include continued stem counts at known populations and additional surveys for successful fruiting at several locations, including plants that occur at low and high flow levels.

3.0 Other Rare Riparian Plants

3.1 Background

The riparian zone adjacent to the Columbia River provides habitat for numerous rare or unusual plant species (Table 1). Focused riparian surveys were conducted at five locations along the Columbia River in late September 2013 (Figure 13). Efforts were divided between examining previously documented sites to provide limited trend information, and searching for previously undocumented rare plant populations. Previous surveys had been performed at or in the vicinity of three of the sites (100-B/C, 100-D, and White Bluffs Slough); while relatively, little previous information was available for the other two survey locations (100-D Horn and 100-F Slough).

Four species listed as threatened or sensitive by the WNHP were observed during the 2013 riparian surveys. These species included lowland toothcup (*Rotala ramosior*), Canadian St. John's wort (*Hypericum majus*), awned half-chaff sedge (*Lipocarpha aristulata*), and chaffweed (*Anagallis minimus*). Another rare riparian species known from the Hanford Reach, the grand redstem (*Ammania robusta*) was not observed during the 2013 field surveys; it normally flowers slightly earlier in the year than the other rare riparian species.

3.2 Lowland Toothcup

Lowland toothcup is an obligate wetland plant (USACE 2014) that occurs across much of the United States. Globally, it is considered secure (rank G5) (NatureServe 2014), but the status of the species varies greatly across the overall range. It is considered to be secure (rank S5) in several southeastern states, but it is considered critically imperiled (S1) or imperiled (S2) in many northern and western states (NatureServe 2014). In Washington State, it is considered critically imperiled, and the WNHP lists it as threatened. Populations in Washington State are widely separated and several historic populations are thought to be extirpated. The Hanford Reach population is likely the largest in Washington State; other extant populations are located in Klickitat, Chelan, and Spokane counties (WNHP 2013).

Lowland toothcup was the most frequently encountered riparian rare plant in 2013, and was found to be relatively common at all five of the survey areas. This finding is similar to that described previously (Salstrom and Easterly 1995, Salstrom et al. 2012). This species was not previously noted at the 100-D survey site, and the area occupied by the species at the 100-B/C and White Bluffs Slough survey sites was greatly expanded compared to previous surveys and database information. Except for one small portion of the site, lowland toothcup was the only rare riparian plant species noted at the 100-F Slough survey site.

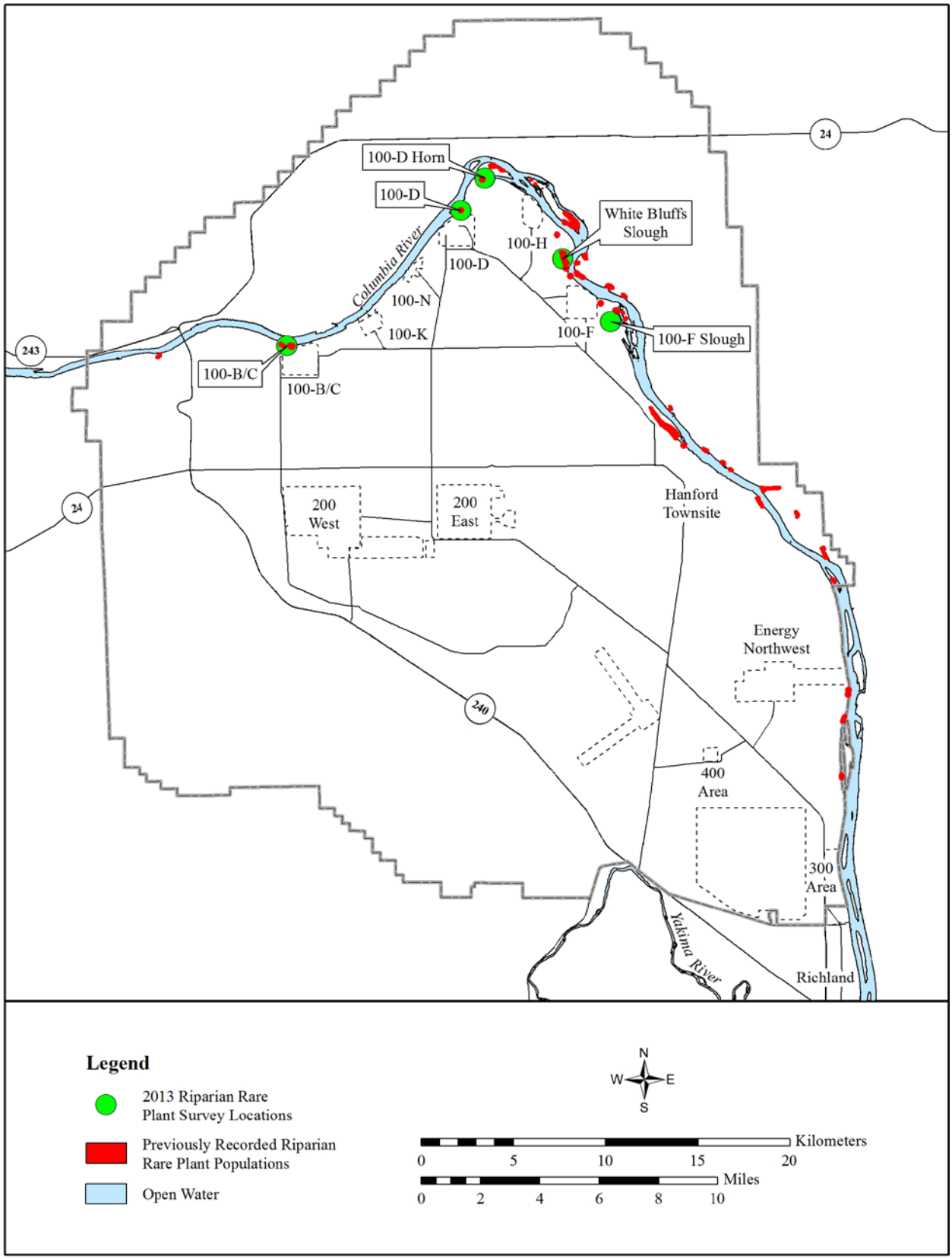

Figure 13. Location of Riparian Rare Plant Surveys Performed in 2013

3.3 Canadian St. John's Wort

Canadian St. John's wort is a facultative wetland plant (USACE 2014) that occurs across southern Canada, the northeast and upper midwest portions of the United States, and in scattered portions of the Pacific Northwest. Globally, it is considered secure, but in many peripheral portions of its range it is considered vulnerable (S3), imperiled, and in a few areas, critically imperiled (NatureServe 2014). In Washington State it is considered imperiled, and the WNHP lists it as a Sensitive species (WNHP 2013). Besides the Hanford Reach populations, other known populations in Washington State are in the northeast (Pend Oreille and Spokane Counties) and in several areas west of the Cascades (WNHP 2013).

In 2013, Canadian St. John's wort was found at four of the five survey locations; it was not observed at the 100-D Horn site and it was found in only one small area at the 100-F Slough survey site. The species was relatively common at the 100-D and White Bluffs Slough sites; at both of these locations the 2013 surveys found it to be distributed over a greater area than suggested by previous information. The 2013 survey was the first to find Canadian St. John's wort at the 100-B/C shoreline wetland area.

3.4 Awned Half-chaff Sedge

The awned half-chaff sedge is a facultative wetland species (USACE 2014) that occurs through the Great Plains, sporadically along the southern United States border, and at scattered locations through the west coast states. It is considered an introduced plant in several southeastern U.S. states. The species is considered to be secure through most of its range, but it is considered critically imperiled in the Northwest, including Washington State (NatureServe 2014). The WNHP lists the species as Threatened. In Washington State, the only known populations are near the Columbia River - along the Hanford Reach, and upstream of Hanford near the border between Yakima and Kittitas counties. In 2013, awned half-chaff sedge was found at all of the survey sites, although it was found at only one small location within the 100-F Slough survey site. Awned half-chaff sedge and lowland toothcup were the only rare riparian species observed at the 100-D Horn site. It was found in several new parts of the 100-B/C wetland, and its range within the 100-D Horn and White Bluffs Slough survey sites were extended.

3.5 Chaffweed

Chaff weed is a facultative wetland plant species (USACE 2014) that occurs throughout the lower Mississippi valley, Florida, and Arizona through most of California to Oregon, with scattered distribution from Washington State and southern Canada across the northern Great Plains. Throughout most of its range, chaffweed is considered to be secure, but its status in significant portions of its range varies from vulnerable to critically imperiled (NatureServe 2014). In Washington, it is imperiled and it is listed by WNHP as a Sensitive species.

Chaffweed was found less frequently than the other rare riparian species during the 2013 field surveys. However, it was observed at all of the survey sites except the 100-D Horn site.

The limited monitoring performed in 2013 indicated that previously known populations of rare riparian plant species on the Hanford Reach appear to be stable, the boundaries of known populations were expanded, and several new populations were identified. Future monitoring will continue to focus on both assessing the status of known populations and identifying new populations in under-explored portions of the shoreline.

4.0 Literature Cited

Caplow, F., 2003, *Studies of Hanford Rare Plants, 2002*, Unpublished report prepared for the Washington Office of The Nature Conservancy, on file at the Washington Natural Heritage Office, Olympia, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601-9675. (P.L. 96-510).

DOE/EIS-0222-F. 1999. Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement, U.S. Department of Energy, Washington, D.C. Online at: http://energy.gov/nepa/downloads/eis-0222-final-environmental-impact-statement-0

DOE/RL-96-32, Revision 1. 2013. *Hanford Site Biological Resources Management Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at: http://www.hanford.gov/files.cfm/doe-rl-96-32-01.pdf.

HRFCPP, 2004, *Hanford Reach Fall Chinook Protection Program Executed Agreement*, Hanford Reach Fall Chinook Protection Program. Online at http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2006/draft/app7.pdf.

National Environmental Policy Act of 1969, 42 U.S.C. 4321, et seq. (P.L. 91-190).

NatureServe, 2014, *NatureServe Explorer* website. Online at: http://www.natureserve.org/explorer/.

PNNL-20548. 2010. *Hanford Site Environmental Report for Calendar Year 2010*,Pacific Northwest National Laboratory, Richland, Washington. Online at http://msa.hanford.gov/msa/filedisplay.cfm?fileid=1467.

Salstrom, D. and R. Easterly, 1995, Riparian plant communities: south shore and islands of the Columbia River on the Hanford Site, WA. Prepared for The Nature Conservancy, Seattle, Washington.

Salstrom, D., R. Easterly, C. Lindsey, and J. Nugent, 2012, *Rare Plant Monitoring Report for Calendar Year 2011*, HNF-52260 Rev. 1, Prepared for the U.S. Department of Energy, Richland, Washington. Online at http://www.hanford.gov/files.cfm/hnf-52260_-_rev_01.pdf.

Salstrom, D., R. Easterly, C. Lindsey, and J. Nugent, 2013, *Rare Plant Monitoring Report for Calendar Year 2012*, HNF-54686. Prepared for the U.S. Department of Energy, Richland, Washington. Online at: http://www.hanford.gov/files.cfm/hnf-54686_-_rev_00_.pdf.

WNHP, 2011, *Confidential occurrence records for Rorippa columbiae*, Washington Natural Heritage Program, Department of Natural Resources, Olympia, Washington.

WNHP, 2013, *List of Vascular Plants Tracked by the Washington Natural Heritage Program*, Washington Natural Heritage Program, Department of Natural Resources, Olympia, Washington. Online at http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html