HNF-73141
Revision 0

Assessment of Crayfish on the Hanford Reach of the Columbia River for CY 2023 and 2025

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

Contractor for the U.S. Department of Energy
Hanford Field Office under Contract 89303320DEM000031

P.O. Box 943
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

Assessment of Crayfish on the Hanford Reach of the Columbia River for CY 2023 and 2025

C. T. Lindsey
Hanford Mission Integration Solutions (HMIS)

K. J. Cranna
Hanford Mission Integration Solutions (HMIS)

W. S. Thompson
Hanford Mission Integration Solutions (HMIS)

Date Published
July 2026

Environmental

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

Contractor for the U.S. Department of Energy
Hanford Field Office under Contract 89303320DEM000031

P.O. Box 943
Richland, Washington 99352

Copyright License
By acceptance of this article, the publisher and/or recipient acknowledges the U.S. Government's right to retain a non exclusive, royalty-free license in and to any copyright covering this paper.

APPROVED
By Susan Natalie Molina at 2:07 pm, Aug 06, 2026

Release Approval | Date

Approved for Public Release;
Further Dissemination Unlimited

LEGAL 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 any third party's use or the results of such use 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 or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report has been reproduced from the best available copy.

Printed in the United States of America

Assessment of Crayfish on the Hanford Reach of the Columbia River for CY 2023 and 2025

Prepared by

C.T. Lindsey
Hanford Mission Integration Solutions, LLC

K.J. Cranna
Hanford Mission Integration Solutions, LLC

W.S. Thompson
Hanford Mission Integration Solutions, LLC

Date Published
July 2026

Prepared for the U.S. Department of Energy
Hanford Field Office

Contract No. 89303320DEM000031

TRADEMARK DISCLAIMER

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 or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

The cover photo features a collection of crayfish from the Columbia River near the Hanford Site 300 Area.

TABLE OF CONTENTS

TABLE OF CONTENTS 1-2

LIST OF FIGURES 1-2

LIST OF TABLES 1-2

1.0 INTRODUCTION 1-3

2.0 METHODS 2-6

3.0 RESULTS 3-10

4.0 DISCUSSION 4-13

5.0 REFERENCES 5-1

APPENDIX A ANALYTICAL RESULTS I

APPENDIX B CRAYFISH COLLECTION SUMMARY I

LIST OF FIGURES

Figure 1-1. Native Signal Crayfish (Above) and Invasive Virile Crayfish (Below) 1-4
Figure 2-1. Cross-section of the Near Shore River Zone (adapted from DOE/RL-2007-21). 2-6
Figure 2-2. Crayfish trapping locations from 2023 and 2025. 2-7
Figure 2-3. Baited funnel traps. 2-8
Figure 3-1. Crayfish Collection Locations and Species Distribution for 2023 and 2025. 3-11
Figure 3-2. Mass Comparison of Virile vs. Signal Crayfish. 3-12
Figure 4-1. Artificial Refuge Trap (Green et al., 2018). 4-13

LIST OF TABLES

Table 2-1. Summary of Sample and Analytical Requirements. 2-9
Table 3-1. Summary of Metals Analyses from 2023 and 2025 Crayfish. 3-10

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Hanford Field Office (HFO) 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 HFO activities. Ecological monitoring data provides baseline information about the plants, animals, and habitat under HFO stewardship on the Hanford Site, which is required for accurate ecological impact assessment decision making under the *National Environmental Policy Act* and the *Comprehensive Environmental Response, Compensation, and Liability Act*. In addition, ecological monitoring helps ensure that HFO, its contractors, and other entities conducting activities on the Hanford Site comply with DOE/EIS-0222-F (1999), *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement*.

Crayfish are an important component of the benthic macroinvertebrate assemblage in the Columbia River and are recreationally caught and consumed by members of the public. Crayfish accumulate essential and nonessential elements and pollutants and could present a risk to consumers through the dietary pathway and contribute to bioaccumulation of contaminants in wildlife predators (e.g., fish, raccoons, herons). In the Hanford near-shore environment, crayfish are exposed to any chemical and radiological contaminants that may be present in sediment, surface water, and emergent groundwater associated with seeps and groundwater upwelling.

Crayfish are considered a good indicator species for radiological and chemical contamination in aquatic environments due to their relatively long lives (3 years) and small home ranges of typically less than a 30 m radius over 4 weeks (USFWS, 2015). They are also a good bioindicator for metals pollution in freshwater systems because they are known to accumulate heavy metals, particularly in the hepatopancreas. The hepatopancreas is a very metabolically active organ that sequesters contaminants and contributes to the detoxification process. Typically, the lowest concentrations of pollutants are observed in the abdominal muscle, the edible part of the crayfish (Goretti, et al., 2016).

Two species of crayfish have been previously documented along the Hanford Reach of the Columbia River. The signal crayfish (*Pacifastacus leniusculus*) is native to the Pacific Northwest and the Columbia River. Previous observations and collections of crayfish along the Hanford Reach over the previous 20 years, although not identified to species, were presumably signal crayfish (DOE/RL-2005-40, 2006; PNNL-13692, 2002). It is identified by its uniform brownish or blue-tinged coloration as adults with a white band at the joint of the claws. The surfaces of the crayfish are quite smooth (especially the claw) compared to other crayfish. An invasive species, *Faxonius virilis*, commonly known as virile crayfish or northern crayfish is also present in the Hanford Reach (Figure 1-1). According to the United States Geological Survey (USGS, 2026), the species was first observed in Washington State in 2006 in the upper Columbia River but was not documented in the Hanford Reach until 2020. The virile crayfish is a medium to large crayfish and is distinguished from the signal crayfish by broad flattened tuberculate (i.e., large tubercules) claws, an olive-brown body dappled with dark brown, and abdominal segments with brown medial spots.

Figure 1-1. Native Signal Crayfish (Above) and Invasive Virile Crayfish (Below)

The invasive virile crayfish species may negatively impact native species including the signal crayfish, potentially competing for resources or directly consuming them. Of particular concern, these invasive crayfish are documented to consume fish eggs, which could impact the fall

chinook salmon (*Oncorhynchus tshawytscha*) that spawn along the Hanford Reach. These fish represent the largest run remaining in the Pacific Northwest, and are highly important ecologically, culturally, and economically for the region (Dauble and Watson, 1997). Virile crayfish could also impact the benthic community, especially species of concern such as the shortface lanx (*Fisherola nuttallii*) and ashy pebblesnail (*Fluminicola fuscus*), as virile crayfish are documented to reduce snail populations (Hanson et al., 1990).

The invasive *F. virilis* is of interest to the Environmental Monitoring program due to its status as a possible new and expanding invasive species in the Hanford Reach, and due to the species being a potential vector for Hanford Site contaminants-of-concern to ecological receptors and the public. The primary objective of this pilot study is to collect information regarding Columbia River crayfish for evaluation as a species for routine collection supporting the Hanford Environmental Monitoring program.

Study questions include the following:

- Are crayfish present for collection in areas of interest in the near shore environment (e.g., Environmental Monitoring program seep and/or sediment sampling locations)?
- Are crayfish species easily identified (i.e., virile crayfish versus signal crayfish)?
- Are crayfish easily trapped with use of funnel and bait boxes or do they require other methods?
- Are sufficient crayfish available within the sampling area to achieve laboratory sample mass requirements?

Collecting contaminant information specific to evaluating toxicity and contaminant uptake in crayfish, particularly associated with concentrations in the hepatopancreas was beyond the scope of this pilot study. However, whole body crayfish were submitted for radionuclide and metals analysis as an initial assessment of contaminant levels to support future planning activities for possible bioaccumulation studies and environmental monitoring.

2.0 METHODS

Crayfish were collected in the near-shore river environment defined as the area that is permanently inundated by river water, extending from the low-water mark into the river to a depth of approximately 2 m as depicted in Figure 2-1. The near-shore river zone includes locations where groundwater seeps enter the Columbia River. River bottom substrate is an important factor influencing the distribution of crayfish and large substrates provide refuge from predators as well as protection from high river flows.

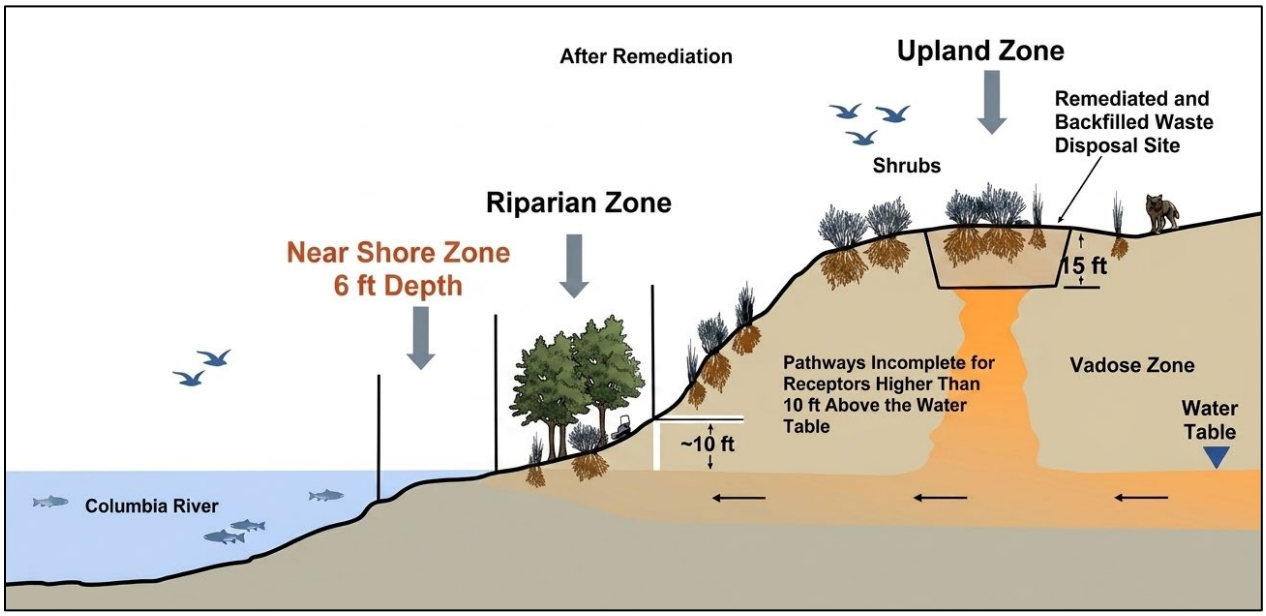

Figure 2-1. Cross-section of the Near Shore River Zone (adapted from DOE/RL-2007-21).

Trapping occurred over two years, and the methods were refined during year two to improve sampling success. In 2023, crayfish sampling was planned for locations where shoreline seeps discharge at the Columbia River shoreline and/or river sediment is routinely sampled as part of the Hanford Environmental Monitoring program (Figure 2-2). Locations that are collocated with annual seep sampling and river sediment sample collection are preferred as the water and sediment data may be useful for supporting calculations of site-specific bioaccumulation. In 2025, additional areas with suitable habitat were sampled when crayfish were not available near seep/sediment locations. Crayfish collections were also completed at upstream reference locations to evaluate the availability of reference samples and to provide initial comparisons of analytical results.

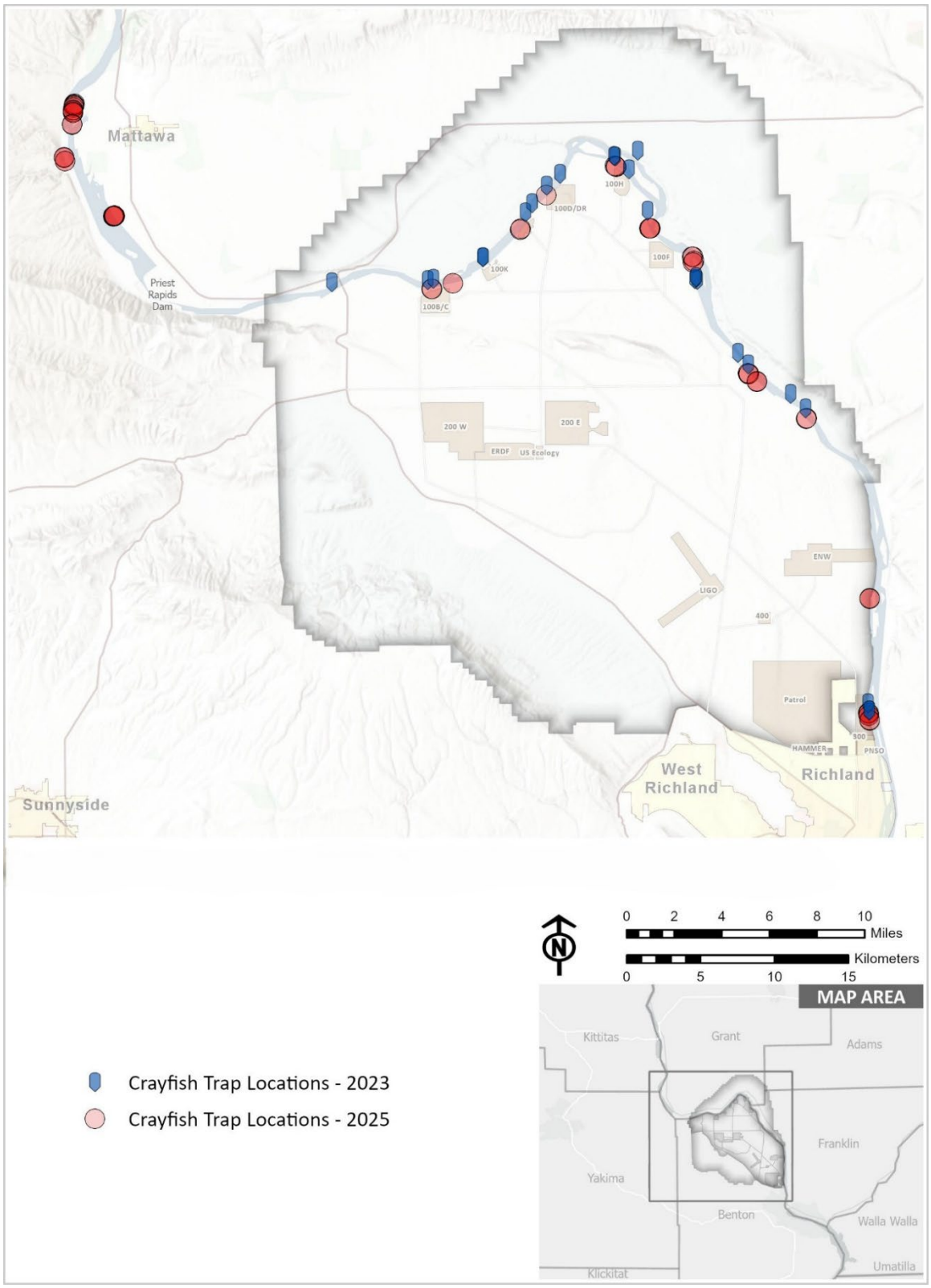

Figure 2-2. Crayfish trapping locations from 2023 and 2025.

Crayfish were collected from selected sampling sites using baited funnel traps (Figure 2-3). Traps were baited with canned cat food in 2023 and raw chicken in 2025. Traps had foam float markers in 2023 which were swapped for rebar anchors in 2025 to avoid possible navigation hazards associated with the floats being left overnight. This allowed for more extensive overnight trapping in 2025, increasing available trapping time to approximately 24 hours for all traps in 2025.

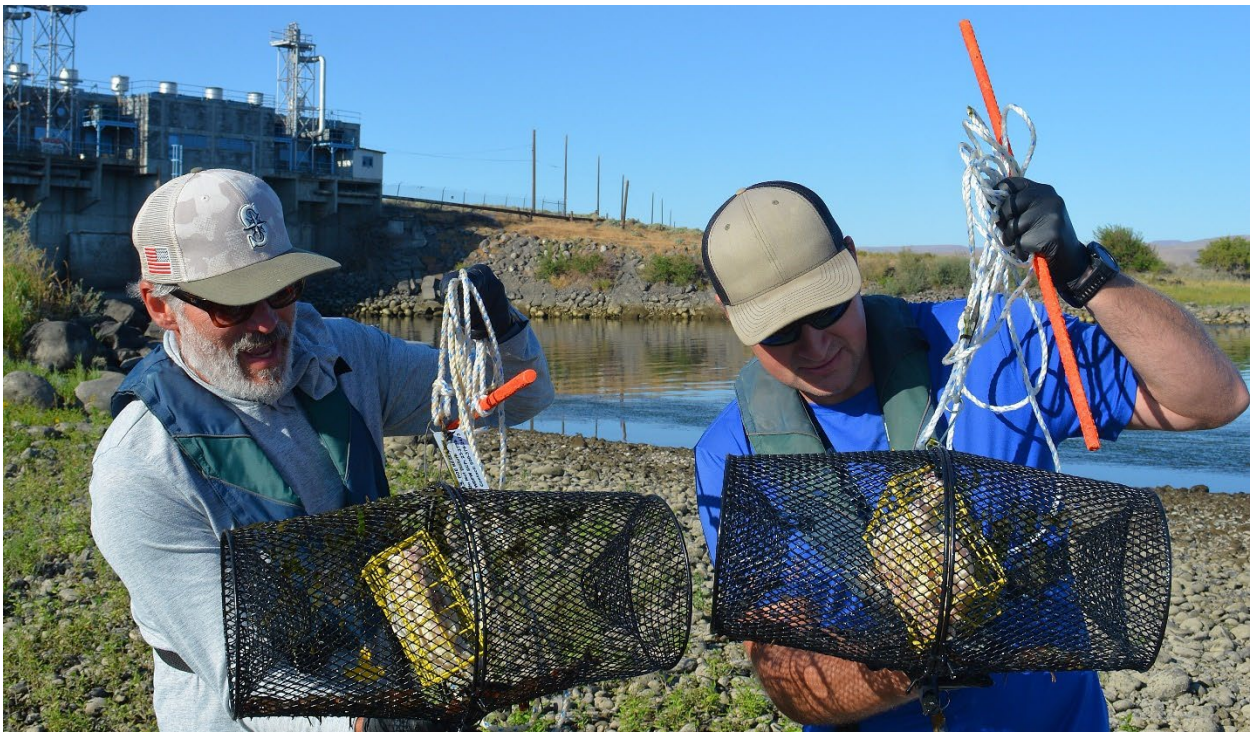

Figure 2-3. Baited funnel traps.

Captured crayfish were euthanized and identified to species prior to bagging and placing on ice for transport. Crayfish were weighed individually in 2023 to obtain average mass for each species, individual weights were not collected in 2025. Multiple crayfish were composited as whole individuals within individual trap clusters at single locations. When necessary to obtain target sample mass, crayfish from multiple adjacent sampling areas were combined including areas up to ~11 river miles apart.

Analytical performance requirements for crayfish samples are those currently used for tissues of fish and wildlife for the Environmental Monitoring program and as specified in the Hanford Site Environmental Monitoring Plan (DOE/RL-91-50, 2018) and as specified in the analytical laboratory statement of work. Table 2-1 provides a summary of the analytical methods, container materials, preservation, and holding times.

Table 2-1. Summary of Sample and Analytical Requirements.

Matrix	Mass	Analytical Method	Sample Container	Storage	
				Preservation	Holding Time
Tissue (whole body individuals)	200 g homogenate	Metals ICP 6010	Polyethylene bag	Freeze at ≤ -20 °C	6 months[a]
		Mercury 7471 CVAA	Polyethylene bag	Freeze at ≤ -20 °C	28 days[a]
		Radionuclides GEA Sr-90 GPC	Polyethylene bag	Freeze at ≤ -20 °C	6 months

[(a)] Maximum holding times recommended by U.S. Environmental Protection Agency (EPA 823-B-00-007, 2000).
CVAA = cold vapor atomic absorption
ICP = inductively coupled plasma
GEA = gamma energy analysis
GPC = gas proportional counter

Upon receipt of the sample, the laboratory prepared the crayfish in the sample as directed in instructions provided by HMIS for sample homogenization. The laboratory then prepared aliquots as required for the following analyses:

- Gamma energy analysis (GEA)
- Strontium-90
- ICP 6010 metals
- Mercury (7471 CVAA)

3.0 RESULTS

Sample locations from 2023 and 2025 are shown in Figure 3-1. The two crayfish species were not evenly distributed along the Hanford Reach. There were more signal crayfish and fewer virile crayfish in the upper part of the Hanford Reach, and the opposite trend existed in the lower river. Virile crayfish were only detected as far upstream as the White Bluffs Slough in 2023 and up to the 100-D area in 2025. Both species occurred in the upstream reference area (above Priest Rapids Dam).

Twenty-six crayfish were trapped in 2023 including 9 signal crayfish and 17 virile crayfish over three sampling days. Four composite samples were submitted for analysis. A single sample from 2023 had a detection of strontium-90 (0.217 pCi/g). This detection is slightly more than the 0.14 pCi/g dose-based reporting limit of 1 mrem/yr for fish intake (DOE/RL-91-50, 2018). No other radiological contaminants were detected above laboratory minimum detectable levels.

A total of 189 crayfish were captured in 2025 over two trap nights including 41 signal crayfish and 148 virile crayfish. Seven composite samples were submitted for analysis. No radiological contaminants were detected above laboratory minimum detectable levels. Across samples from 2023 and 2025 concentrations of metals detected in crayfish samples from the Hanford Reach are similar to concentrations measured upstream in the reference samples. These metals are also detected in annual Columbia River sediment samples. Potassium-40, a naturally occurring radioactive isotope, was detected in all samples from 2023 and 2025 but is not considered a contaminant-of-concern on the Hanford Site. A summary of analytical results is provided in Table 3-1, and detailed analytical results are included in Appendix A.

Table 3-1. Summary of Metals Analyses from 2023 and 2025 Crayfish.

Constituent	# Detects/ # Samples	Maximum (ug/kg)		Constituent	# Detects/ # Samples	Maximum (ug/kg)
Aluminum	11/11	87000		**Lead**	0/11	ND
Antimony	5/11	1190		**Manganese**	11/11	42400
Arsenic	3/11	622		**Mercury**	2/11	636
Barium	11/11	152000		**Nickel**	11/11	377
Cadmium	0/11	ND		**Selenium**	3/11	1670
Chromium	6/11	753		**Silver**	10/11	1400
Cobalt	3/11	375		**Uranium**	1/11	1060
Copper	11/11	31100		**Zinc**	11/11	32000
ND = not detected						

An Anderson-Darling Normality Test showed that the mass of virile (p=0.253) and signal (p=0.844) were normally distributed, but with unequal variance Bartlett's Test (p=0.001). As such a Kruskal-Wallis Test was completed to compare the median of the mass of the two groups, showing that the virile crayfish were significantly larger (28g) than the signal crayfish (14g) (H=8.2, df=1, p=0.004). A comparison of the signal and virile crayfish mass is provided in Figure 3-2. Appendix B provides a summary of the number of crayfish by species caught at each sample location in 2023 and 2025.

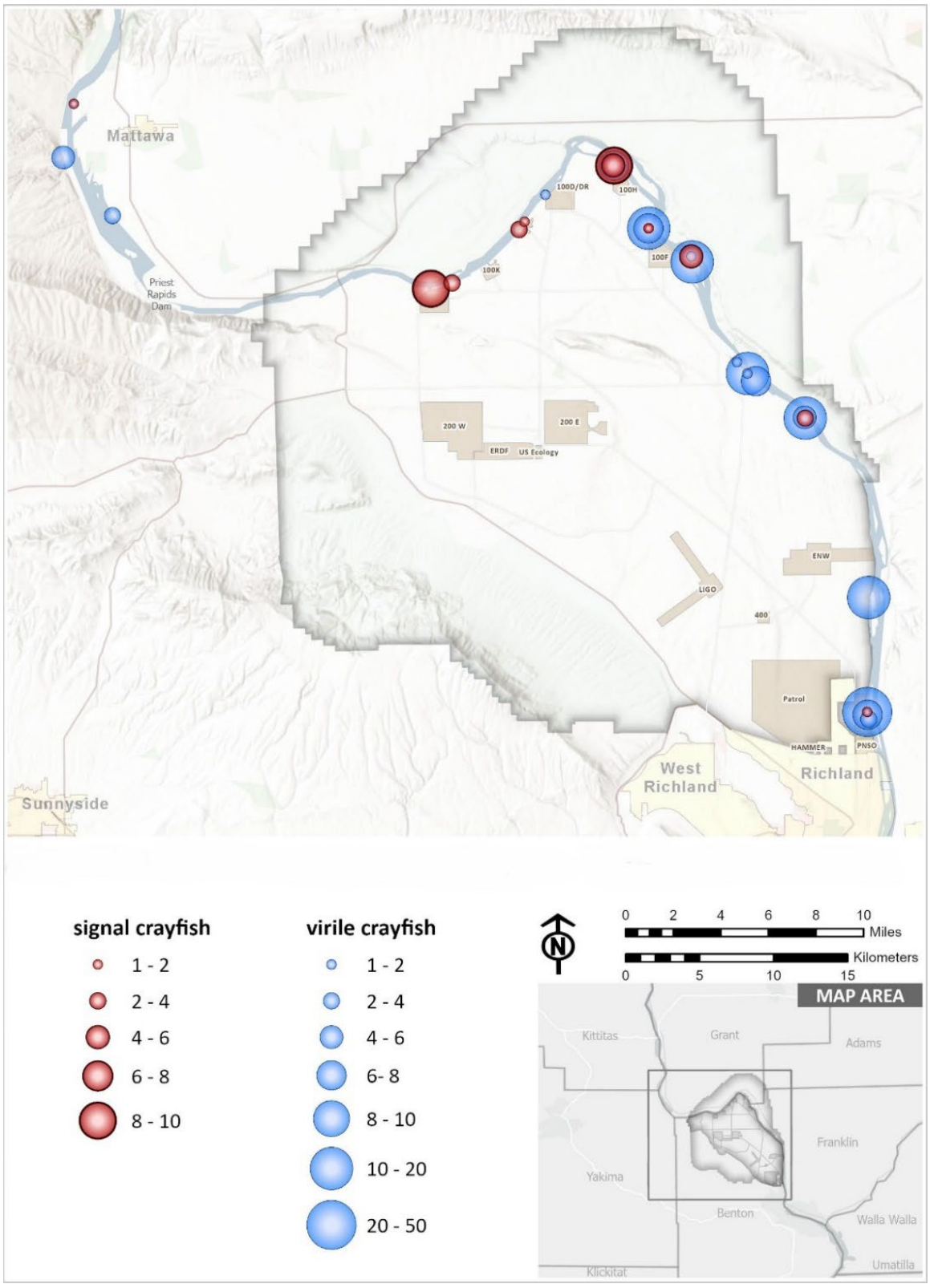

Figure 3-1. Crayfish Collection Locations and Species Distribution for 2023 and 2025.

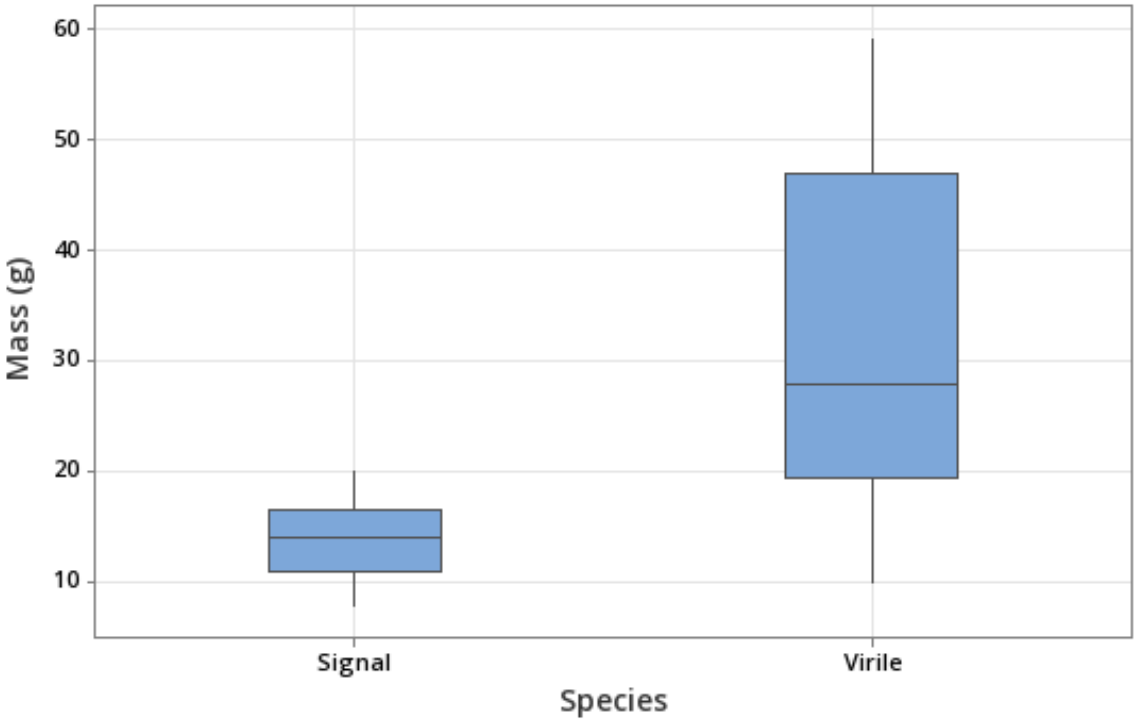

Figure 3-2. Mass Comparison of Virile vs. Signal Crayfish.

4.0 DISCUSSION

This pilot study showed that crayfish are available along the Hanford Reach in sufficient numbers to obtain required minimum sample mass. Crayfish are also present, but apparently less abundant in the Priest Rapids pool. Because crayfish are present in sampleable numbers, and because members of the public are consuming crayfish along the Hanford Reach, they will be included in the Environmental Monitoring program's annual sampling schedule beginning in 2026.

Trapping success was greatly improved from 2023 to 2025 through a combination of changes/enhancements. Continued efforts to improve trapping techniques could result in greater mass, lower field effort, and less compositing across multiple locations. Possible considerations for improving catch per unit effort include the addition of white lights to the traps, which were shown in a recent study to double the trapping efficiency for virile crayfish compared to bait alone (Wildhaber et al., 2025). Another option could be using artificial refuge traps (ART) composed of open sections of PVC pipe, which one study showed had significantly higher capture rates than baited funnel traps (Green et al., 2018). The ART consists of sections of PVC approximately 3-5 cm in diameter and 15-25 cm in length that are blocked at one end with a metal mesh and open at the other end. ART could potentially be added to existing funnel traps to increase trap rates. Independent ART can also be deployed for longer periods without the need to check for trapped individuals, because animals can freely enter and leave, allowing crayfish to find and occupy the ART prior to collection efforts.

Figure 4-1. Artificial Refuge Trap (Green et al., 2018).

The evaluation of the bioaccumulation level of heavy metals in crayfish hepatopancreas with respect to sediment contamination may be useful for evaluating toxicity and supporting assessment of the benthic community and may be planned and requested for future crayfish sampling based upon results of this pilot study.

Trace metal concentrations can have negative impacts on crayfish abundance, and some metals such as cadmium and lead may be potentially toxic to crayfish and may be an important determinant of crayfish distribution and abundance. Goretti et al. (2016) studied metals accumulation in selected tissues of red swamp crayfish and developed an index to assess biological response in contaminated sites and evaluate heavy metal toxicity levels. The study found that crayfish accumulated higher concentrations of heavy metals in the hepatopancreas than in the abdominal muscle, consistent with literature data. Concentrations also appeared to be higher at the industrial sites than at the reference sites.

The limited trapping effort during both years does not likely show the entire extent of the invasive species along the Reach, but continued sampling may show if the species is expanding its range upriver over time and possibly replacing the native signal crayfish. Field observation suggested predation of the signal crayfish by the virile crayfish in the traps, demonstrating the threat that the much larger invasive species poses against the native. If sufficient mass of virile crayfish is available to support sampling targets, it may be worthwhile to release signal crayfish to minimize impacts. Members of the public are also likely to consume the larger virile crayfish at higher rates, so this may also better characterize the potential human exposure pathway.

The preferred habitat for the invasive virile crayfish along the Hanford Reach appears to be backwater areas and current seams with large cobble or boulders available for cover. They may be excluded from areas selected by salmon for spawning due to characteristic high currents and small gravel substrates. Further investigation is warranted, as any impact on the salmon would be cause for concern. These could include additional trapping efforts during the spawning season or scuba/snorkel surveys in salmon spawning areas. The virile crayfish pose a threat to native crayfish, salmon, and likely other native members of the benthic community including sensitive snail species. Further characterization of the extent of invasion, and possibly population control efforts could be warranted. After publication, the location information collected during this study will be submitted to the USGS nonindigenous aquatic species database at www.nas.er.usgs.gov.

5.0 REFERENCES

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601-9675.

Dauble, D. D. and D. G. Watson. (1997). *Status of Fall Chinook Salmon Populations in the Mid-Columbia River, 1948–1992*. North American Journal of Fisheries Management 17 (2): 283 300. Online here.

DOE/EIS-0222-F. (1999). *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*. U.S. Department of Energy. Online here.

DOE/RL-2005-40. (2006). *100-BC Pilot Project Risk Assessment Report*, *Draft B*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2007-21. (2010). *River Corridor Baseline Risk Assessment Volume II: Human Health Risk Assessment*. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2022-37. (2023). *Hanford Site Environmental Monitoring Master Sampling Schedule for Calendar Year 2023*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-50. (2018). *Hanford Site Environmental Monitoring Plan, Rev. 8*. U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online here.

EPA 823-B-00-007. (2000). *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1, Fish Sampling and Analysis, Third Edition*, U.S. Environmental Protection Agency, Washington D.C.

Green, N., M. Bentley, P. Stebbing, D. Andreou, R. Britton. (2018). *Trapping for invasive crayfish: comparisons of efficacy and selectivity of baited traps versus novel artificial refuge traps*. Knowl. Manag. Aquat. Ecosyst., 419 (2018) 15. Online here.

Hanson, J.M., Chambers, P.A. and Prepas, E.E. (1990), *Selective foraging by the crayfish Orconectes virilis and its impact on macroinvertebrates*. Freshwater Biology, 24: 69-80. Online here.

National Environmental Policy Act of 1969, 42 USC 4321, et seq.

PNNL-13692. (2002). *Survey of Radiological and Chemical Contaminants in the Near-Shore Environment at the Hanford Site 300 Area*, Pacific Northwest National Laboratory, Richland, Washington.

Goretti, E., Pallottini M., Ricciarini, M. I., Selvaggi, R., and Cappelletti, D. (2016). Heavy Metals Bioaccumulation in Selected Tissues of Red Swamp Crayfish: An Easy Tool for Monitoring Environmental Contamination Levels. *Science of the Total Environment*, 559, 339-346. Online here.

USFWS. (2015). *Virile Crayfish (Orconectes virilis) Ecological Risk Screening Summary*, U.S. Fish and Wildlife Service, Washington D.C. Online here.

USGS, 2026, *Faxonius virilis* (Hagen, 1870): Nonindigenous Aquatic Species Database, Gainesville, FL, Revision Date: 7/24/2019, Peer Review Date: 11/13/2017, Access Date: 6/30/2026. Online here.

Wildhaber M. L., Bates, B. L., Beaman, Z. D., Bennett, K. R., and West, B. M. (2025). Combined effectiveness of light and bait to enhance trapping for monitoring and removal of invasive crayfish: virile crayfish example. *Management of Biological Invasions*, 16(4): 1033–1051. Online here.

APPENDIX A
Analytical Results

		Composite Locations and Sample Date										
Analyte	**Unit**	100-H and 100-N	White Bluffs Launch	300 Area and Savage Is.	Han Slough and Townsite	100-B/C, 100-K, 100-N, 100-D, 100-H	White Bluffs	100-F Area	Townsite to Savage Is.	Wooded Is.	300 Area	Reference
		10/24/2023	10/25/2023	10/23/2023	10/23/2023	8/21/2025	8/21/2025	8/21/2025	8/21/2025	8/21/2025	8/21/2025	8/28/2025
Antimony-125	pCi/g	< -0.00580	< -0.0112	< -0.00849	< 0.0221	< 0.00957	< 0.00431	< -0.0129	< 0.00241	< -0.00717	< 0.0145	< -0.00813
Beryllium-7	pCi/g	< -0.0832	< 0.0791	< 0.156	< -0.0299	< 0.0968	< 0.00501	< 0.0734	< 0.0421	< -0.0406	< 0.0225	< 0.0125
Cesium-134	pCi/g	< 0.00154	< -0.00572	< 0.0297	< 0.0371	< 0.00540	< -0.00101	< 0.0108	< 0.00163	< 0.0146	< -0.00245	< 0.00147
Cesium-137	pCi/g	< 0.00320	< 0.000879	< 0.00844	< -0.0106	< 0.00165	< -0.00223	< -0.000233	< 0.00400	< 0.0128	< 0.000114	< 0.000302
Cobalt-60	pCi/g	< 0.00925	< 0.000660	< 0.0132	< 0.00115	< 0.00314	< 0.000516	< -0.00404	< -0.00358	< 0.00728	< -0.00127	< -0.000176
Europium-152	pCi/g	< -0.000565	< -0.0219	< 0.0147	< -0.000446	< 0.00909	< 0.00411	< 0.00934	< -0.00619	< -0.00817	< 0.0114	< 0.00325
Europium-154	pCi/g	< -0.0136	< 0.0317	< 0.0297	< -0.00278	< 0.0155	< 0.00676	< 0.00216	< 0.00487	< 0.00358	< 0.00304	< 0.0115
Europium-155	pCi/g	< 0.0211	< 0.00519	< 0.0508	< -0.0678	< 0.0154	< 0.00635	< 0.0433	< 0.00369	< 0.0109	< 0.00901	< 0.0175
Potassium-40	pCi/g	1.96	2.74	1.64	2.21	1.99	2.22	1.58	1.92	1.72	1.53	2.07
Ruthenium-106	pCi/g	< -0.0786	< -0.00559	< 0.000873	< 0.0423	< 0.0249	< 0.00429	< 0.0298	< 0.0285	< -0.0457	< -0.0115	< 0.0123
Strontium-90		< 0.0112	0.217	< 0.0247	< 0.0000215	< 0.00107	< 0.00461	< 0.00888	< 0.0255	< -0.00518	< 0.0186	< 0.0147
Aluminum	ug/kg	32400	10600	47700	79800	14800	7430	18000	12500	28500	19700	87900
Antimony	ug/kg	1190	469	< 300	433	< 283	394	369	< 299	< 322	< 306	< 307
Arsenic	ug/kg	< 423	< 465	< 455	< 456	622	< 483	528	< 453	< 488	589	< 466
Barium	ug/kg	31800	7260	80800	93400	47500	23900	117000	52200	61400	152000	82900
Beryllium	ug/kg	< 84.6	< 92.9	< 90.9	< 91.2	< 85.6	< 96.5	< 95.6	< 90.6	< 97.7	< 92.6	< 93.1
Cadmium	ug/kg	< 84.6	< 92.9	< 90.9	< 91.2	< 85.6	< 96.5	< 95.6	< 90.6	< 97.7	< 92.6	< 93.1
Chromium	ug/kg	< 127	< 139	182	251	< 128	< 145	753	< 136	180	176	194
Cobalt	ug/kg	< 127	< 139	179	375	< 128	< 145	< 143	< 136	< 146	< 139	179
Copper	ug/kg	20900	9070	9260	15100	31100	16500	15700	15300	22400	12200	28800
Lead	ug/kg	< 279	< 307	< 300	< 301	< 283	< 319	< 315	< 299	< 322	< 306	< 307
Manganese	ug/kg	18000	15100	19500	37100	17800	11200	28700	17400	20300	18100	42400
Mercury	ug/kg	< 147	< 151	< 145	< 139	173	< 148	< 139	636	< 141	< 160	< 147
Nickel	ug/kg	217	169	228	453	262	225	199	144	164	178	377
Selenium	ug/kg	1110	< 465	1670	1200	< 428	< 483	< 478	< 453	< 488	< 463	< 466
Silver	ug/kg	134	< 92.9	270	362	698	305	1400	1130	773	1290	760
Thallium	ug/kg	< 423	< 465	< 455	< 456	< 428	< 483	< 478	< 453	< 488	< 463	< 466
Thorium	ug/kg	245	171	< 123	138	< 130	< 127	< 129	< 130	< 114	< 126	< 112
Uranium	ug/kg	< 846	< 929	< 909	< 912	< 856	< 965	1060	< 906	< 977	< 926	< 931
Zinc	ug/kg	14000	4250	22500	20500	17300	30800	21900	18000	32100	25100	22200

Not Detected

APPENDIX B
Crayfish Collection Summary

Year	Species	Number	Latitude	Longitude
2025	*Pacifastacus leniusculus*	10	46.63787300	-119.65242800
2025	*Pacifastacus leniusculus*	4	46.64122300	-119.63375000
2025	*Pacifastacus leniusculus*	4	46.67327500	-119.57398800
2025	*Pacifastacus leniusculus*	10	46.71152400	-119.48924900
2025	*Pacifastacus leniusculus*	1	46.67310000	-119.45932400
2025	*Pacifastacus leniusculus*	6	46.65561700	-119.42207800
2025	*Pacifastacus leniusculus*	4	46.55610500	-119.32350100
2025	*Pacifastacus leniusculus*	1	46.37657400	-119.27281000
2025	*Pacifastacus leniusculus*	1	46.75235300	-119.96674000
2025	*Faxonius virilis*	2	46.69428200	-119.55024300
2025	*Faxonius virilis*	8	46.71152400	-119.48924900
2025	*Faxonius virilis*	16	46.67310000	-119.45932400
2025	*Faxonius virilis*	1	46.65561700	-119.42207800
2025	*Faxonius virilis*	11	46.65219700	-119.42129400
2025	*Faxonius virilis*	12	46.58383300	-119.37378500
2025	*Faxonius virilis*	8	46.57908100	-119.36639200
2025	*Faxonius virilis*	11	46.55610500	-119.32350100
2025	*Faxonius virilis*	16	46.44629400	-119.26997400
2025	*Faxonius virilis*	41	46.37657400	-119.27281000
2025	*Faxonius virilis*	8	46.37494800	-119.27256000
2025	*Faxonius virilis*	4	46.37221200	-119.27170300
2025	*Faxonius virilis*	1	46.75235300	-119.96674000
2025	*Faxonius virilis*	6	46.71974900	-119.97640400
2025	*Faxonius virilis*	3	46.68411000	-119.93322800
2023	*Pacifastacus leniusculus*	2	46.67800000	-119.56900000
2023	*Pacifastacus leniusculus*	5	46.71161000	-119.49000000
2023	*Faxonius virilis*	1	46.67298630	-119.45955250
2023	*Pacifastacus leniusculus*	2	46.67298630	-119.45955250
2023	*Faxonius virilis*	8	46.67298630	-119.45955250
2023	*Faxonius virilis*	1	46.59086010	-119.38300010
2023	*Faxonius virilis*	1	46.58381000	-119.37400000
2023	*Faxonius virilis*	5	46.55658000	-119.32400000
2023	*Faxonius virilis*	1	46.37663000	-119.27300000