Evaluating Impact and Efficiency of Water Stargrass Mechanical Harvest

A Review of Harvesting Operations from 2021-2023

Photo Credit: Benton County Mosquito Control District, 2023

Prepared for the Department of Ecology, Yakima Basin Integrated Plan
Agreement: #WRYBIP-2123-BentCD-00018

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Executive Summary

Water stargrass impedes flow and function on the Lower Yakima River, lowering water quality and favoring invasive species. Until recently, no agency had attempted to mitigate impacts of water stargrass on the river. This report details the management approaches implemented by Benton Conservation District during baseflow conditions in 2022 and 2023. Mechanical harvest of water stargrass was identified as a viable option because of expected increases in the scale of areas able to be removed relative to hand harvesting. Mechanical harvesting did allow for larger scale removal of stargrass where more than one acre could be cleared per day, with 3 cubic yards of material removed with each load of the harvester. During harvesting immediate improvements in flow were noted with movement of invasive species out of the harvested areas. A reduction in grass density was noted in areas harvested the previous year, demonstrating multi-year benefits of harvesting. Limitations for efficiency of removal include having to ferry material to suitable offloading sites and access for launching the harvester.

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1.1 Introduction and Scope of Work

The proliferation of native water stargrass on the lower Yakima River represents a novel problem that started in the early 2000s. The rapid growth and spread of this species has degraded water quality, impaired fish passage, altered river flows, and clogged water diversion structures. Water stargrass also creates habitat for disease carrying mosquitos, invasive fish, and amphibians. While removal of water stargrass will likely alleviate these problems, no large-scale approaches have been undertaken and it is unclear how feasible and effective efforts may be.

Figure 1. Large swath of growth of water stargrass on the Yakima River.
Photo Credit: Benton County Mosquito Control District

1.2 Harvesting Efforts by Benton Conservation District

The Benton Conservation District (BCD) purchased a custom-built harvester (Figure 2) in 2020 with funding from a Washington State Department of Commerce grant. The harvester purchase provides opportunity to evaluate the feasibility of larger scale mechanical water stargrass removal in the Yakima River. A conveyor to offload material was also purchased by BCD, but will not arrive until 2024 due to supply chain challenges.

In 2021, BCD secured grant funding through the Yakima Basin

Figure 2. Benton Conservation District's mechanical aquatic harvester.
Photo Credit: BCD

Integrated Plan (YBIP) under the Department of Ecology Agreement (WRYBIP-2123-BentCD-00018) to test pilot the harvester in the lower Yakima River at three locations with boat launch access, sufficient depth and known biomass growth. BCD investigated the feasibility and logistics of mechanical harvesting as a tool for seasonal water stargrass control in 2022 and 2023. This document provides a summary of the approaches used by BCD for aquatic harvesting and identifies the lessons learned with possible solutions for future effective and efficient plant control operations.

1.3 Location of Harvesting Work

Harvesting occurred in the lower Yakima River at three locations (Figure 3). Sites were selected based on boat launch presence and characteristics, offloading opportunities, and density of stargrass in the immediate area. Water depth and velocity were also considered. Additional site details are provided later in the report.

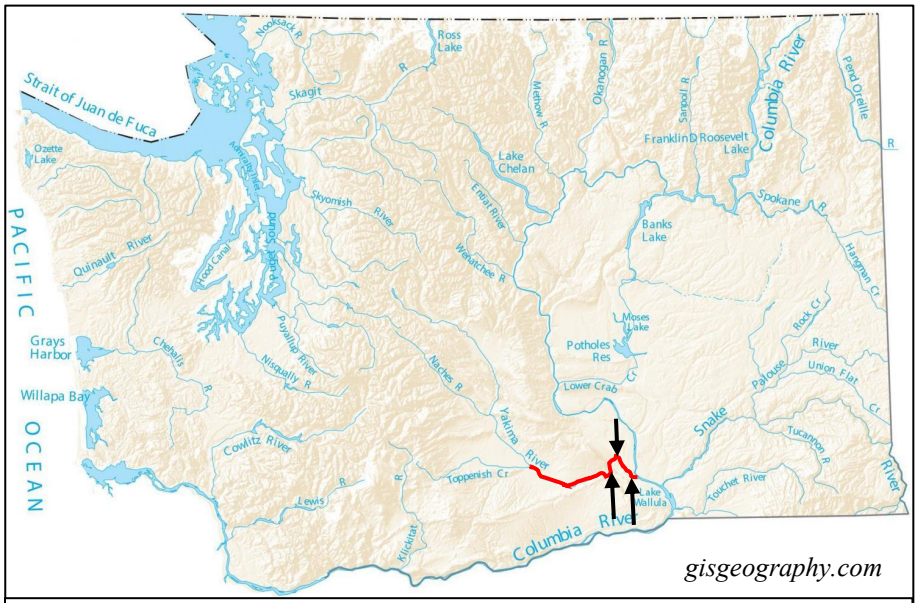

Figure 3. Location of the lower Yakima River outlined in red in Washington State. Three harvesting locations shown with black arrows.

2.1 2021 and 2022 Harvesting Operations

The aquatic harvester was received late in the summer of 2021. While the delivery timing did not allow for harvesting, it did provide initial test cutting of water stargrass and staff training to operate the craft. Cutting operations were performed with the sickle cutter head attachment (Figure 4) which shears the stems of aquatic vegetation. The roller head attachment (Figure 2) pinches plant material between the head and a second smaller roller to pull entire plants including removal of the root material. The harvester is powered by a 23.5 horsepower diesel engine that turns two paddle wheels and an additional propeller (bottom left of Figure 2). The propeller can be lowered into the water on the rear of the boat for additional thrust when the cutter or roller head is not in use. A conveyor belt on the front of the boat moves cut or pulled material up out of the water and into the bunk, which has a

Figure 4. Harvester using the sickle cutter head. *Photo Credit: BCD*

capacity of three cubic yards. This conveyor is flipped, and the direction reversed in order to unload material from the bunk. While material can be offloaded directly onto the shore in some conditions, material is generally offloaded onto a trailer or additional conveyor system for disposal (Figure 5).

Figure 5. Pile of harvested water stargrass. *Photo Credit: BCD*

In 2022, the harvesting season was delayed because of late spring rains that sustained high river flows through mid-July. The increased river flows delayed seasonal biomass growth and harvesting operations by 6 – 8 weeks. Harvesting operations on the lower Yakima River can only occur during the in-stream work window from June 15th through September 15th. For the 2022 season, harvesting took place in late August and the first two weeks of September. A summary of harvesting metrics for 2022 are shown in Table 1. Unfortunately, harvesting operations were not able to take place when biomass was at its peak growth for 2022, which was in late October.

For the 2022 pilot treatments, five harvesting locations at three sites were selected based on boat launch access and biomass presence. The pilot areas were located near the Benton City Public Boat Launch, Horn Rapids Park (above the Horn Rapids Dam), and the Yakima River Delta. Table 1 provides a summary of the 2022 water stargrass removal operations.

Table 1. Summary of 2022 Harvesting Operations

Treatment Sites and Locations	Dates	Approximate Area Harvested	Estimated Biomass Removed	Notes
Benton City **APE 1** **APE 2** **Other**	8/16/2022	0.01 Acre	3 cubic yards	Launch Site was too swift and shallow for unloading and trailering. Lengthy time to return upriver to boat launch. Only cut one bedload due to current
Horn Rapids Park	8/22/2022- 8/29/2022	1.5 acres	108 cubic yards	Slower, impounded water allowed for easier trailering, cutting and offloading
Yakima Delta	9/7/2022	None	None	Lacking accessible areas for harvester unloading Long ferry time from Columbia Park Boat Launch to delta

3.1 2023 Harvesting Operations

In 2023, large-scale harvesting was more successful than the previous year because river flows allowed boat access and peak WSG growth occurred within the permitted work window.. A total of 26 days were spent harvesting during the harvest window, totaling 145 equipment hours, and 285 loads of stargrass were harvested (855 cubic yards). In order to meet harvesting goals, BCD hired an additional seasonal staff member for the 2023 harvesting season (Figure 6).

Figure 6. Full load of water stargrass being offloaded. *Photo Credit: BCD*

To determine fresh biomass removal capacity of the harvester, four separate harvesting loads were weighed with commercial scales. Full loads averaged ~2,000 lbs., therefore approximately 504,900 lbs. of stargrass were removed from the river during the 2023 season. The harvesting summary metrics for each site and location are provided in Table 2.

Table 2. Summary of 2023 Harvesting Operations

Treatment Sites and Locations	Dates	Approximate Area Harvested	Estimated Biomass Removed	Notes
Benton City **APE 1** **APE 2** **Other**	8/7/2023- 8/25/2023	 0.6 acres 1.0 acres 4.1 acres	210 cubic yards	Launch site was challenging, but feasible if river height is above 3.5 ft. Offloading access provided by private landowner
Horn Rapids Park	7/25/2023- 9/15/2023	15.3 acres	471 cubic yards	Slower, impounded water allowed for easier trailering, cutting and offloading
Yakima Delta	8/1/2023-9/7/2023	9.8	174 cubic yards	Long ferry time to cutting site, but access for offloading provided by US Army Corps

Harvesting efficiency varied greatly between sites as a result of differences in hydrogeology such as swift water currents or a variable riverbed that makes harvesting challenging. Slower moving water with consistent riverbeds and nearby offloading access resulted in the most efficient harvesting where an average of 2.7 loads per hour could be

removed from the river. Using a dump trailer was necessary (Figure 7) to move material from the offloading site to a staging area where stargrass is allowed to dry and then be taken to a composting facility. Shoreline access was necessary in areas without vehicle access. Material is offloaded onto the shore and then pulled up above the waterline using hand tools. This approach requires additional manual labor and a suitable shore with deep enough water to approach the bank.

Figure 7. Dump trailer preparing to offload material next to other piles unloaded that same day. *Photo Credit: BCD*

During harvesting, surface mats and islands were removed resulting in visible improvements in river conditions. Movement of woody debris was observed following removal of especially dense patches of stargrass that were accumulating floating vegetation or debris. Trash was manually removed from the river with objects as large as a freezer door taken from the river and disposed of properly. While removal of surface islands visibly improved river conditions, dense water stargrass growth below the water surface was also removed that improved flow and appeared to allow sediment to move as gravels were sometime visible several days after harvesting. These results are more challenging to quantitatively assess, but nonetheless are expected to have benefits to water quality and aquatic wildlife.

3.2 Biomass Monitoring and Disposal

During harvesting near Horn Rapids Park, water stargrass was piled with permission from Benton County Parks at the southern end of a gravel parking lot in the park. In 2023, the volume of grass was so large that stargrass piles were spread by hand to facilitate drying and allowing more material to be unloaded on top. These piles were monitored from the time they were piled in July, August, and September until they were collected and taken to the Richland City Landfill in December of 2023. The temperature of stargrass averaged 89 °F when the air temperature was 86 °F. By comparison, adjacent piles of lawn clippings measured over 120 °F on the same day.

Figure 8. Removal of stargrass using a skid loader with grapple bucket attachment and dump trailer. The disturbed soil was re-seeded with native grasses the following week. *Photo Credit: BCD*

At other sites, water stargrass was unloaded on the river bank and manually pulled up the shore. Piles were spread and placed on bare soil when possible in order to minimize disturbance of riparian vegetation and allow for

drying. Piles were monitored visually as they dried, shrinking down to only a few inches tall, usually within 2 weeks depending on weather.

The majority of biomass when pulled from the river is composed of water. As the large piles of water stargrass dried, total volume decreased. Although a rainy fall and winter resulted in wet and soggy material, biomass of stargrass remained reduced. A total of just over 50,000 lbs. of material were removed from Horn Rapids Park using a skid steer (Figure 8). Some dirt and rock were unintentionally captured in the removal of stargrass as is expected when using large equipment to move material in contact with the soil. The disturbed area was seeded with native grasses shortly after removing water stargrass using the Benton Conservation District's ATV pulled broadcast seeder that also uses a drag mat to smooth soil.

4.1 Water Stargrass Characteristics, Growth Habit, and Response to Harvest

In recent years, water stargrass has flourished each summer in response to warm water temperatures and decreased turbidity that increased light penetration. However, the 2022 growth season for water stargrass presented atypical characteristics as a response to unusually high precipitation and cooler spring and early summer temperatures as documented by Pelly and others (2024 *in prep*). Large areas of water stargrass were observed growing later in the summer of 2022 than typical. This is likely to have been a result from lower water temperatures that decreased growth rates as well as increased water velocities that may have scoured and displaced existing root material. Additionally greater water depth, increased turbidity from sustained flushing flows, and limited light penetration reduced growth rates until later in the season. In 2023, thick patches of stargrass returned to the system although slightly later (~2-3 weeks) in the season than commonly observed. River hydrology is dynamic and requires flexible management approaches because the total amount of biomass and growth timing varies each year. However, consistent challenges with dense water stargrass remain each year for wildlife, irrigators, and recreators.

Figure 9. Photo taken July 2023 prior to any harvesting shows the area harvested in 2022 within the dashed red line. Stargrass is typically most dense near the shore and reaches the surface more quickly than in deeper parts of the river. *Photo Credit: BCD*

The areas harvested in 2022 and 2023 near the Benton City Public Boat Launch and Horn Rapids Park appeared to remain clear for the remaining duration of the summer and fall, as no visible regrowth was observed. The area harvested during the 2022 season (Figure 9) had visibly less water stargrass in the following year than adjacent areas that were not harvested. When harvesting this same area during the 2023 season, the stargrass present was shorter and less dense than in other areas upstream or on the opposite bank. The multi-year reduction in water stargrass indicates that harvesting of vegetation likely provides addition benefits to water quality through

the fall, winter, spring, and following summer. Previous work hand pulling water stargrass where high percentages of roots where removed resulted in 3 years without vegetation before the area was recolonized (personal communication, R. Little, BCD). While it is not expected that harvesting operations remove roots as effectively as hand pulling, it is unclear what patterns of regrowth will occur in harvested areas. Riverbed characteristics and water depth both affect harvest success and the amount of root material that is captured by the harvester's roller head.

4.2 Observed Harvesting Impacts in 2022 and 2023

During the 2022 and 2023 harvesting season, removal of thick patches of water stargrass resulted in immediate changes in water flow at the harvested locations. Increases in water movement immediately following harvesting were evident. Mats of aquatic vegetation (primarily water stargrass) are often caught by water stargrass patches that have reached the surface. Harvesting these patches results in other debris and floating vegetation not associated with harvesting moving down the river as the plants anchoring these floating mats are removed. as the material that anchored these floating mats is removed. These immediately observable results are encouraging that problem areas where river flow is reduced can be rapidly mitigated through physical removal of biomass with the harvester.

Changes in behavior of invasive and native species were observed following removal of stargrass islands. Bullfrogs and a variety of insect species sit or land on stargrass islands. Removal of these islands resulted in a change in distribution of these species. Most notably, frogs were observed in high density on stargrass near the shore where the harvester was unable to access. As many as 12 frogs were seen within an area of less than a square yard. Movement of fish such as carp and catfish were observed moving through dense patches of stargrass and changes in behavior were noted with removal of the water stargrass that provides cover.

5.0 Tracking Harvesting Activities and Management of Harvested Material

During harvesting of water stargrass, a Lowrance Sonar Unit (Lowrance HDS 9 -Live, Active Imaging 3 in 1 Transducer) with built in GPS was capturing data on the location of the vessel, the depth of water, and vegetation characteristics. These data were compiled at the end of each harvesting season and analyzed using BioBase online software. Images show the path of the harvester, and the density of vegetation and allow determination of broad patterns of water stargrass growth and effectiveness of harvesting activities. Estimated harvested areas were determined using GPS location to quantify areas traveled by the harvester. These data also aided in visualizing the large number of passes required within an area to clear thick vegetation due to the relatively small size of the cutting head (4 feet).

Images showing vegetation characteristics depict no vegetation with blue and increasing vegetation density with green, yellow, orange, and red respectively (Figure 10). Data analyzed using BioBase more accurately quantified observations made by operators. These include the increase in density of vegetation moving up the Yakima River relative to the Columbia River and in the delta (Figure 10A), and increased presence of water stargrass closer to the shore relative to

the center of the river (Figure 10B). Increases in water stargrass growth were also closely associated with water depth. This pattern was not noted by operators as stargrass often grows in water as deep at 8 feet and observations are often limited to shallow water when conditions such as sunlight and water turbidity allow vegetation below the surface to be easily viewed. Harvesting on cloudy days or when water was turbid resulted in no observations made as only surface vegetation could be seen. Density of vegetation could also be assessed from the path of travel made by the harvester over several days (Figure 10C). Greater vegetation density and

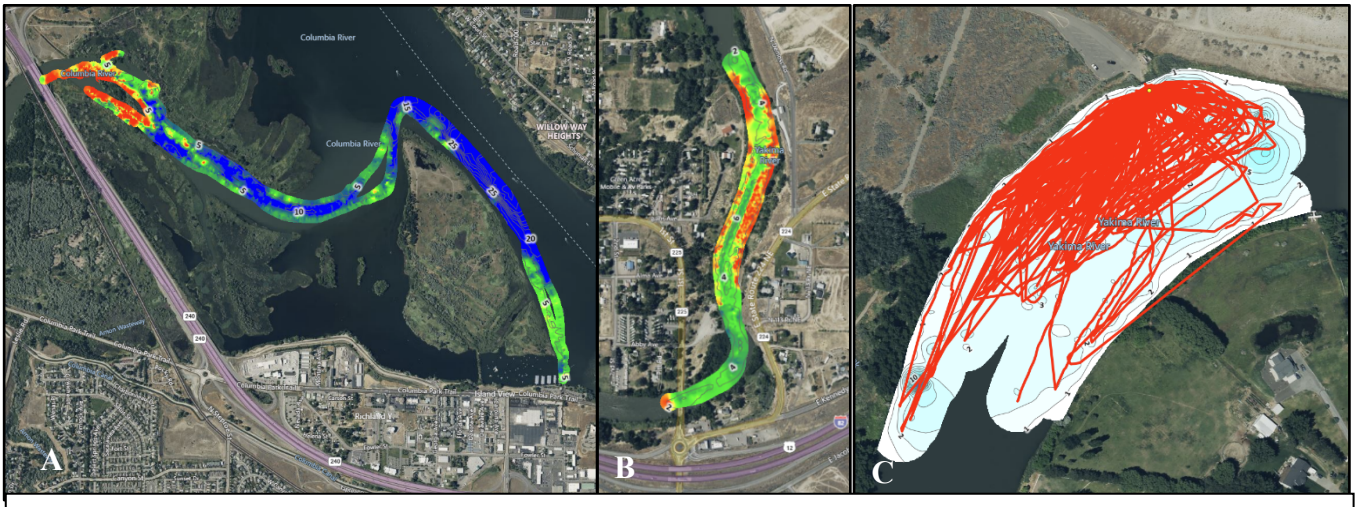

Figure 10. Panels A and B show vegetation density data collected by sonar at the mouth of the Yakima River and in the Columbia River (A), and at Benton City (B) in 2023. Blue overlay indicates no vegetation with green, yellow, orange and red showing increasing density of vegetation (A and B). Red lines show the path of the harvester in the Yakima River near Horn Rapids Park (C) during August of 2023.

water depth required additional passes to be made on the same areas in order to clear water stargrass in that area.

Impacts of harvesting were captured when comparing vegetation characteristics captured during harvesting earlier within the work window relative to those captured at the end of the harvesting window. Data was compiled during harvesting in August and compared with data collected during two days in September. Although water stargrass was actively growing during this time a reduction in aquatic vegetation was quantified using sonar data (Figure 11). Reductions in vegetation density can be observed visually when

Before
8/7/2023 -9/1/2023

After
9/11/2023 and 9/14/2023

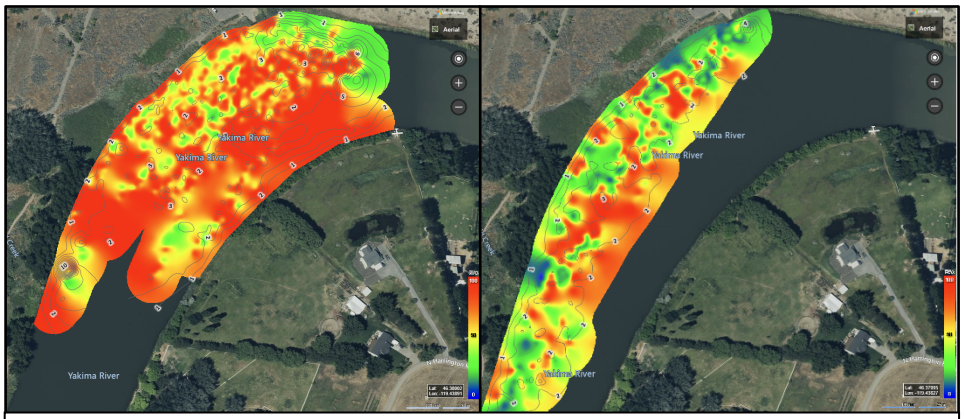

Figure11. Panels A and B show vegetation density data collected by sonar in the Yakima River near Horn Rapids Park during August (A) and in September (B).

comparing “before” and “after” images, but also by quantifying vegetation characteristics calculated from sonar data. The percent of the total area that has vegetation present went from 95.6% before harvesting to 63.3% after harvesting. Additionally, areas with vegetation are categorized as having 100-80% of the water column occupied with vegetation (biovolume), 80-60% biovolume, 60-40% biovolume, 40-20% biovolume, and 20-0% biovolume. All categories decreased during the “after harvesting” measurement, except for 20-0% biovolume, because more areas had reduced, or no vegetation near the end of harvesting.

6.0 Examining Requirements for Effective Harvester Operations

Large aquatic mechanical harvesters are by nature heavy, long, and slow. These characteristics can pose limitations in accessing harvesting sites. Launching close to patches of water stargrass can be challenging because locations are limited to areas with an improved launch pad and minimal current in order to successfully deploy and re-trailer the harvester.

Figures 12 and 13 show the launch sites and locations where harvest occurred at Benton City and the Yakima Delta. At Benton City, the close proximity of dense grass and offloading access provided by a private landowner increased efficiency. However, the swift current posed challenges and required additional time, operator expertise, and equipment for safe launching and trailering. Additionally, currents were too swift for the harvester to traverse more than a quarter mile upstream to reach additional patches of stargrass. Furthermore, when harvesting downstream of the private landowner offload site, the harvester struggled to move upstream with a full load, greatly increasing the time required for each load.

Figure 12. Benton City Public Boat Launch, with launch location identified in with red arrow. Approximate areas harvested in 2023 are shown in green shading. Areas of potential effect (APE) where water quality parameters were measured are shown in red shading with APE 1 just downstream of the launch and APE 2 farther downstream.

Figure 13. Columbia Park Trail Boat Launch identified in red and approximate harvest areas shown in green shading.

The final site, at Horn Rapids Park (Figure 14) water velocity is lowered due to Horn Rapids dam that is approximately one-half mile below the launch location. In combination with a slower current, water stargrass could be harvested upstream of the launch site, which was used to offload material. This allowed the harvester to take advantage of the current once full, and improve overall efficiency.

Figure 14. Horn Rapid Park Boat Launch, with launch location identified in red and approximate harvest areas shown in green shading.

With the harvester's low travel speeds (maximum speeds in still water are approximately 3.5 mph), launch locations near harvest areas will increase efficiency. Identifying suitable launching locations represents a major limitation for harvesting vegetation as many areas of high impact may be inaccessible or require hours of travel to reach. New launch sites may be needed for the harvester to access critical locations in the river where stargrass may be preventing clear passage of water for aquatic habitat or irrigation.

Additional limitations to efficient harvesting include available unloading sites. Current permitting approval requires that cut water stargrass is removed from the water and not returned to the river to drift downstream. Cut material is loaded onto the bunk until filled then returned to shore for unloading. When harvesting thick vegetation with a nearby loading site, the harvester can fill the bunk and offload more than 3 times per hour. The rapid filling of the bunk reflects the ability of the harvester to pull vegetation rapidly and effectively from the water, but demonstrates the large scale of the invasion and amount of water stargrass biomass present within this reach. To streamline operations, unloading sites must be near harvesting operations and have sufficient depth so that the harvester can approach the bank. If either of these conditions are not met, the time spent traveling to the unloading location and navigating shallow water areas more than doubles the time spent harvesting. This can also occur after the areas nearby the offloading location have been harvested and travel time is required for moving to up or downstream areas.

Revisiting the application of "cut and drift" for locations with poor site accessibility may be necessary for efficient harvesting operations. The dislodging and transport down the river of water stargrass is a characteristic of the plant that occurs throughout the growing season and especially in the fall when unrooted vegetation above the riverbed dies and is then carried down the river. Mimicking the natural pattern of movement where water stargrass moves down the river would likely be the most effective harvesting strategy, where water stargrass would be cut but not pulled into the bunk. Using a cut and drift method, much greater areas of the river could be cut without requiring transport to unloading locations. The cut and drift method would greatly reduce the need for labor and time while also significantly increasing the ability to access areas that currently cannot feasibly be harvested.

While a larger harvester unit may have a greater capacity to cut or skim vegetation and also to hold more onboard before unloading, these harvesters are not suited for the shallow conditions of the Yakima River. Harvesting vegetation in depths of approximately two feet was common during operations of 2022 and 2023. Therefore, increasing the scale of harvesting in the lower Yakima is unlikely to be done through larger machinery. This custom-built harvester was shown to be well suited for rapid cutting and pulling of vegetation within the lower Yakima (Figure 15). Total operation size could be increased by adding multiple similar sized machines or adding smaller harvesters for shallow areas. A fleet of machines could work simultaneously in critical areas but would greatly increase costs and staff requirements.

Figure 15. Harvester pulling water stargrass near Horn Rapids Park. Swaths where stargrass has been removed are evident. *Photo Credit: BCD*

7.0 Mechanical Harvester Modifications

Mechanical challenges are not uncommon for large equipment, and some challenges were met as harvesting operations occurred in 2021, 2022, and 2023. Mechanical challenges included boat trailer guides breaking during boat loading, anchor posts jamming or breaking straps during unloading of vegetation, loss of sickle cutter teeth, lost mounting brackets, damage to conveyors and rollers from collisions with rocks, hydraulic leaks, conveyors becoming misaligned with drive chain guides, and movement or collision of moveable attachments such as the seat, sonar transducer, and rear propeller. These issues were addressed by custom metal work to improve the boat trailering guides, building of extra straps with metal connectors, re-enforcement of brackets, and pins added to secure attachments. These modifications, and maintenance including changing filters, greasing, debris removal, and general cleaning were able to be performed by skilled workers at Benton County Mosquito Control Board and BCD. This partnership reduced time spent waiting on repairs as well as expenses because work was completed rapidly in-house and at cost. While these issues had only minor impacts on harvesting, they did add delays to field work. Addressing them ensures the safety of operators and a more efficient use of time to prepare the harvester for use each day. The improvements made to the trailer and boat equipment will help with future harvesting operations. We anticipate that the harvester will require routine maintenance each season along with repairs and modifications.

8.0 Limitations to Harvesting Operations

Primary limitations to removing vegetation for the 2022 field season included the elongated wet spring of 2022, which delayed growth of water stargrass and prevented harvesting until later in the season. This allowed only a few weeks when operations could optimally take place before the work window closed. We also encountered challenges with river velocities, staging locations, and offloading sites.

To overcome limitations in work window timing in the future, the use of a seasonal employee, an additional employee from another project, and sharing labor from Franklin Conservation District during harvest operations of 2023 greatly increased the number of hours spent harvesting. However, large-scale harvesting still requires an increase in staff numbers and would improve the amount of time spent harvesting during the critical window of time. Additionally, the number of hours spent harvesting are limited each day due to the preparation of equipment and harvester transport and launching. This time cost highlights the benefit of additional labor that could increase the number of hours spent on the river harvesting each day as time spent in transport cannot be minimized. For a sustainable program with long-term operations, it will be important to examine staffing and time management efficiencies for seasonal workload. The consideration of most effective harvesting strategies and addition of seasonal staff are important questions as the BCD has limited staff that fulfills multiple roles within the county, reducing the district's ability to address this widespread and large-scale concern.

Figure 16. Removing an island of stargrass and associated debris from river. *Photo Credit: BCD*

9.0 Assessment of Goals and Future Work

BCD convened a water stargrass workgroup in the first quarter of 2023. This workgroup is composed of several stakeholders and organizations with a vested interest in the lower Yakima River harvesting operations. The work group aids in planning and prioritizing seasonal harvesting operations, providing operation support in the form of equipment, personnel and expertise, and helping to leverage funding to develop a long-term harvesting program. Future meetings in 2024 are planned.

During the 2023 growing season, assessment of previous harvested areas was performed. Continued monitoring will allow for a better understanding of the long-term effects of harvesting on water stargrass growth patterns. The area of water stargrass harvested above Horn Rapids Dam in 2022 was approximately 1.5 acres in size. Having more typical river conditions in 2023

allowed the district to harvest a total area of approximately 30 acres across five locations and three sites. In addition to operations at Horn Rapids Dam and Benton City, BCD was able to secure offloading access at the Yakima Delta. Future work will continue to secure a conveyor to unload aquatic vegetation. The conveyor is expected to increase the distance from shore that the harvester can unload and reduce labor transporting water stargrass onto and off the trailers used for transport and disposal. The conveyor may improve access to sites for unloading if the conveyor is able to reach down banks. Identifying composting facilities that can benefit from this material may alleviate disposal challenges. While strategies have been discussed, no feasible method has yet been identified for utilizing barges to ferry material between the conveyor and shore. Additionally, potential for cut and drift operations will continue to be investigated.

Harvesting of water stargrass is expected to improve water quality by lowering water temperature and reducing daily fluxes of dissolved oxygen and pH. Water quality metrics that included dissolved oxygen and temperature were measured at Benton City during the summer from 2021 through 2023. However, harvesting of targeted areas only occurred in 2023. The impacts of harvesting are being assessed through a partnership with WSU Tri-Cities and results will be reported in Pelly et al., 2024 (*In prep*)

Funding has been secured to continue operating the harvester during the in-water work window of summer 2024. Maintaining access to offloading locations will be necessary to ensure that harvesting can continue to occur efficiently.

10.0 Conclusions

Benton Conservation District aims to prioritize river passageways that may be stagnant or clogged due to water stargrass. Problems arising from dense mats of water stargrass may be able to be minimized for one or more growing seasons by a single clearing of areas surrounding and just upstream of intakes and diversions. Clearing of dense mats may also reduce habitat for disease carrying mosquitos and clear salmon spawning gravels and migration corridors. Focused efforts on specific areas of interest may reduce costs of labor and yield valuable information on the downstream transport of water stargrass.

Figure 17. Water Stargrass on the Yakima Delta in September 2022. *Photo Credit: BCD*

It is important to consider the high density of water stargrass and the large number of miles in the lower Yakima River where flow is reduced due to its aggressive growth. The number of hours that would be required to pull this vegetation in all areas with dense growth vastly exceeds the capacity of a single harvester, even

with nearby access to sites. Therefore, evaluating methods of effective management of water stargrass at the watershed level is a priority for BCD. Although many longer-term watershed level approaches have been considered for managing water stargrass in the lower Yakima River, they will require additional research and financial investments with strong stakeholder support to be implemented. At present, the most cost-efficient and reliable method available continues to be physical removal with instantaneous in-stream benefits observed for both habitat and water quality and we recommend continued development, monitoring, and funding of the water stargrass harvesting program.