The Characterization of Atlantic Salmon Spawning Habitat on the West River, Prince Edward Island

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Jordan Condon - Project Coordinator

The Central Queens Branch of the PEI Wildlife Federation

Introduction

Prince Edward Island (PEI) has established watershed organizations that cover the majority of waterways across the Island. The roots of watershed groups mainly focused on instream habitat enhancement for salmonids. These ongoing efforts are supported by a core funding source, provided by the Provincial government; and with this watershed groups have taken large strides in growing their capacity and knowledge. Though our watershed groups have grown in knowledge there are still areas for growth. Much of the watershed rehabilitation efforts focus on improving adult and juvenile life stage habitat but there is a lack of reproductive habitat improvement efforts and knowledge particular to PEI rivers. The goal of this report is to improve our knowledge furthering our ability to restore and understand spawning habitat for Atlantic salmon.

This report will describe results from environmental variables that were measured around Atlantic salmon spawning habitat (flow velocities, average sized substrate etc). Study sites were based on areas that Atlantic salmon have historically used to create redds, and also included artificial spawning areas that the Central Queens Branch of the PEI Wildlife Federation (CQWF) created during recent stream rehabilitation activities. Study sites were monitored for redd usage during redd surveys in 2022 and 2023. The following will discuss results from redd surveys in relation to the measured habitat variables. The goal of this report is to characterize common variables that salmon prefer when selecting habitat to spawn. This information can be referenced by PEI watershed groups during salmon conservation enhancement efforts.

Spawning Habitat Description

Female Atlantic salmon have developed an instinct when selecting areas for creating redds while spawning. This ability has been naturally selected and is based on the survival of embryos during the incubation period. During the incubation period developing embryos cannot evade deleterious conditions and metabolic demands must be consistently met or mortality will occur. Redd placement must have habitat features to keep developing embryos eggs aerated while removing metabolic wastes. Typical redd placement occurs at the crest of a riffle where the water velocity is increasing as water depth decreases as this creates downward hydraulic pressure that forces water into the hyporheic zone. Common areas that contain these flow characteristics are within the transition zone between pools and riffles where the water depth decreases and velocity increases. Sources of literature state that salmon prefer substrate between 16-64 mm and in areas with water depth ranging from 20-55 cm. These microhabitats have been described by other authors but can vary between rivers. Individual rivers can have

unique habitat opportunities and may result in salmon using slightly different microhabitats than previously described. Atlantic salmon have been noted to use similar tactics as brook trout and place redds over spring water seeps.

The quality of the habitat used to create redds will influence the ability to satisfy the metabolic demands of developing embryos. Degraded habitat will translate into difficulties in meeting these metabolic demands and may ultimately result in lower embryo survival rates. Habitat with excessive siltation or poor spawning substrate can result in inadequate dissolved oxygen delivery due to a reduction in interstitial spaces and reduced oxygen delivery capabilities.

Understanding these variables is an important step in the process when conducting certain specific stream restoration activities. CQWF has been actively working and researching tactics that can help improve spawning habitat in order to increase freshwater production and help improve the local population integrity of West River Atlantic salmon.

Methods

A total of 55 sites had several variables measured in 2023. Variables measured included flow velocity, water depth, stream width, and a random pebble count conducted. Sites chosen for monitoring were based on areas with recorded redds in recent years (<3 years) and some were deemed "*Managed Sites*" as they have structures present that alter hydraulic conditions and encourage spawning over specific areas. These *Managed Sites* are attempts to create new additional spawning habitat areas during CQWF rehabilitation efforts. Site reaches are described as the main West River, Howell's Brook, and Cudmore's (new in 2023) which is situated on the upper main West River (Figure 1). Table 2 indicates which sites were deemed "*Managed*" relative to sites with and without recorded redds. Each site had a physical marker placed on the stream bank aligned with the approximate redd location. This will assist in future measurements, management activities (i.e. bed raking), and ease in recording redds during surveys as a physical marker is much more accurate than using a GPS when within 5m of location. Flagging tape is commonly used to mark redd locations as well on the West River.

Flow velocity measurements were taken at 21 sites on the West River on October 11 with the remaining 34 sites measured on Oct 13 2023. The hydrometric station in Riverdale was reading 1.13m on October 11 and 1.12m on October 13. Water level conditions in 2023 were as low as they could be on those dates due to a relatively wet summer and saturated water table. The hydrometric station in Riverdale should be referenced regularly to have comparable water

conditions (2022 conditions were 1.08m). Drought conditions can reach water levels less than 1.05m.

At each survey location, three flow velocity measurements were taken 8 cm from the stream bottom at the center of redd location, then repeated again 30cm to the right and left of the redd location totaling 9 velocity readings per site. The velocities were averaged and presented as one value for each category (Table 1). Other variables measured included stream width, water depth and size of spawning substrate. Random pebble counts were conducted at each site and resulted in 20 pieces of substrate selected at each site and measured across the x and y axis. Results for these variables are displayed in Table 1.

Redd surveys in 2023 were conducted from November 14 - 27 and sites noted to have redds were documented. Though the total number of Atlantic salmon redds on the West River were considered low in comparison to 2022 (84 vs 141). Survey conditions were not ideal as river conditions were frequently high with lasting impaired visibility. Redd survey results were analyzed in comparison to study sites variables in Table 1 and Table 2. Redd survey results from 2022 were considered in this report and incorporated in the study site usage.

For future reference, these velocities are relative to the current water level and are meant to be taken as a relative comparison between sites. This does not mean the salmon prefer these exact flow velocities as when they arrive to spawn the water levels and velocity at each site will differ from when these measurements were originally recorded.

Study Findings

Environmental variables measured included water velocity, water depth, stream width, and substrate size at 55 sites across three separate locations (Table 1). Sites were monitored for redd usage during the fall spawning season and results were compared to the measured variables in an attempt to delineate trends.

Spawning habitat characteristics varied slightly between locations but remained relatively constant within each location. For example, on average the Howell's Brook sites were slightly slower than the Cudmore sites (1.39 vs 1.98 ft/s) and the main West River sites averaged 1.74 ft/s (Table 1). Sites recorded with redds had an average velocity of 1.72 ft/s and without redds averaged 1.55 ft/sec. Though the one site at Cudmores that had a redd recorded measured at 2.60 ft/sec so this displays the range of velocities at spawning locations.

Stream width displayed the difference of scale of river between the three locations. Howell's Brook is a main tributary to the West River and had an average stream width of 4.3 m while Cudmores is located on the main West River but in the mid to upper watershed and had

an average stream width of 6.4 m (Table 1). The main West River had an average stream width of 9.8 m. Study sites with redds had an average width of 9.5m versus without redds stream width averaging 5.6m. Study site depths were relative to stream widths. The average study site depth on Howell's Brook was 25.5 cm, 34.4 cm at Cudmores and 36.5 cm on the main West River. The average depth at study sites with redds was 34.4 cm versus without redds at 30 cm (Table 1).

A random pebble count was conducted at each of the 55 study sites. There was low variance between sites and locations with substrate size. Average substrate size was 5.1 cm on Howell's Brook and Cudmores and 4.9 cm on the main West River study sites. The average sized substrate at sites with redds recorded was 4.9 cm while sites without redds averaged 5.1 cm (Table 1). Figure 2 displays the distribution of measured substrates for all 55 study sites.

Sites with recorded redds were significantly higher on the main West River when compared to the other locations (22 vs 3 on Howell's Brook and 1 on Cudmores) (Table 1). Though the majority of study sites were on the main West River (n=28 versus Howell's Brook n=21 and Cudmores n=5). Another important result is that 83% of sites without redds were considered "*Managed*". The bulk of these sites were located on Howell's Brook. While 23% of sites with redds were considered "*Managed"* and majority were located on the main West River with two on Howell's Brook (Table 2).

Discussion

Water velocity is an essential variable for an embryo to have a successful incubation period. It must maintain a velocity great enough to satisfy metabolic demands but not too great to displace local substrate. The range of measured velocities across all study sites do not exempt any of the sites from possible redd usage as a site in Cudmores with a high velocity reading of 2.60ft/sec and Howell's Brook at 1.17ft/sec also had redds recorded. This displays the variation in flow velocity spawning habitats may have. Though the study sites on the main West River experienced the highest usage of redds and the average velocity for these study sites were 1.74ft/sec while the average flow velocity considering all the study sites with recorded redds was 1.7ft/sec.

Water depth did not show major significance aside from streams with greater width also had higher average depths (Table 1). The stream width did display that salmon preferred sites on the main river or study sites with widths >9m. This is indicative that salmon prefer to spawn along the lower main West River.

Study sites that were considered "*Managed"* had significantly lower recorded redds than compared to other study sites. This could be the result of a few factors. These "*managed*" sites were rehabilitation efforts by CQWF that aimed to find locations that did not have history of recorded redds but had certain variables that could be altered to become more favorable (i.e. velocity was ideal but too deep or lacked ideal sized substrate). The ability to turn these habitat areas into areas that could potentially start being used in the future is a major step forward with rehabilitation efforts and establishing useful techniques. This will allow groups to start transforming areas not currently used by salmon to spawn into productive spawning habitat and reduce competition in areas frequently used for spawning. The number of "*Managed"* sites on Howell's Brook was the result of extensive rehabilitation efforts in 2021 and 2022 by CQWF and resulted in the ~ 20 sites enhanced. Only a few of these sites had any record of spawning efforts while the vast majority were areas that were altered in an attempt to encourage salmon to begin spawning there. This is important to note as having any of these sites used by salmon while spawning is considered a major success in CQWF's efforts. Though not all of the 21 study sites on Howell's were considered "*Managed*" they do all contain imported Nova Scotia river rock as a result of rehabilitation efforts. The managed sites on Howell's Brook do not contain any "V" structures while all the managed sites on the main West River and Cudmores do. The Howell's Brook managed sites do however have boulders placed to alter flow characteristics to encourage the salmon to spawn over a specific area. It is important to monitor installed structures and *Managed* sites in order to determine rehabilitation success and delineate which factors led to the structures being successful so they can be replicated.

An important take away from this report suitable habitat one year may not be used the following year based on water conditions and salmon preference. Since spawning conditions are never guaranteed to be the same each year having a diversity of spawning habitat available ensures salmon have suitable options. When installing spawning bed structures they should be installed at different depths and velocities to ensure there will be at least one viable option depending on water conditions. For instance, on the West River four "V" structures were installed along the same reach but at different depths to accommodate different water conditions.

Moving forward it is recommended that the study sites are monitored on a yearly basis for redd usage and this report be re-visited in 2025. As more results are gathered from redd surveys the accuracy of the placement of physical site markers will improve and ultimately result in more accurate variable measurements as they're adjusted. Once more results are gathered they can be incorporated into a new report that can be produced in 2025. An additional

recommendation would be requesting input from an expert regarding the statistically analysis of measured variables for a more in depth discussion regarding the study findings.

Appendix

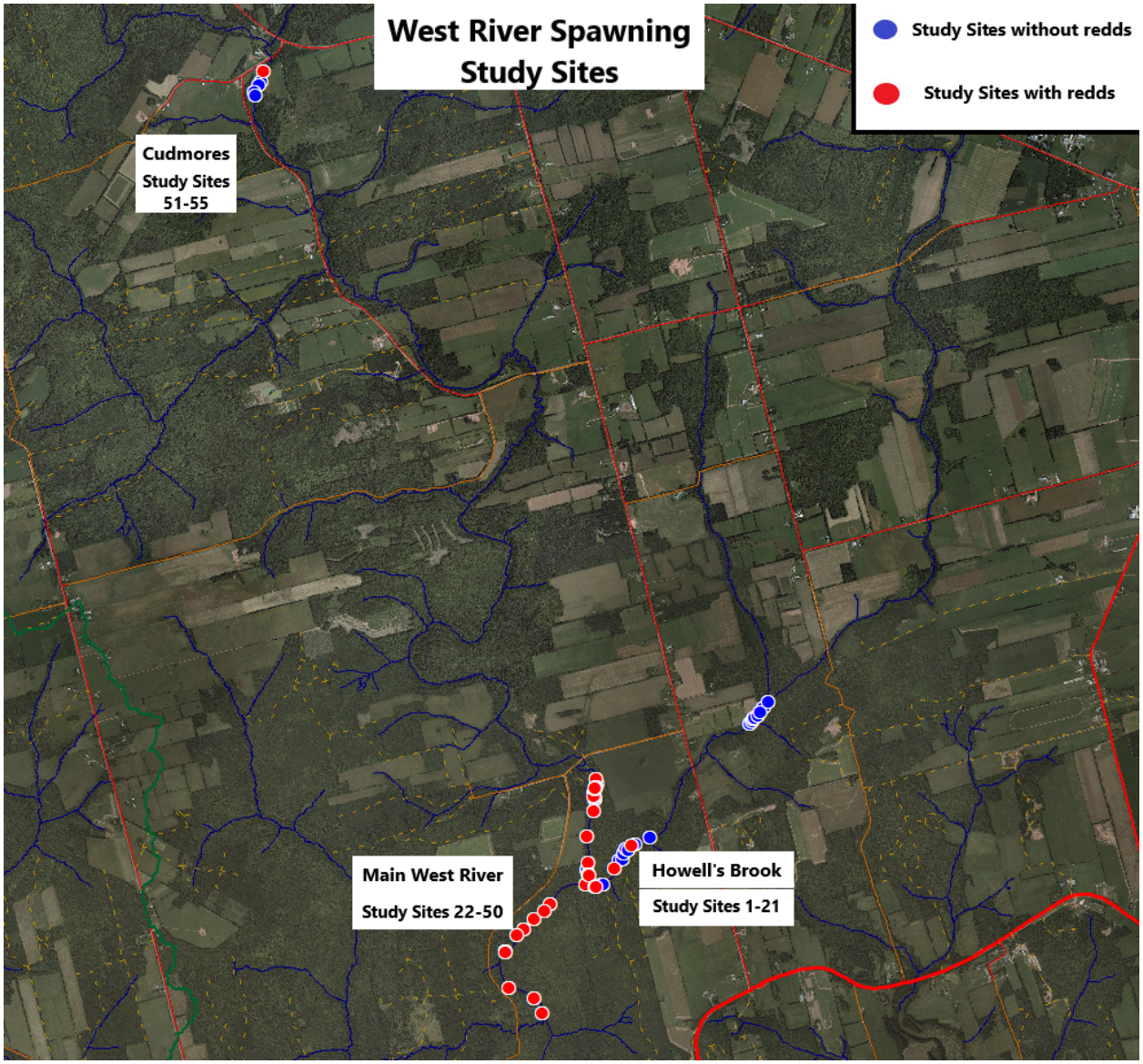


Figure 1. The 55 spawning study sites on the West River across three locations and color coded based on whether redds were recorded or not.

Table 1. Measured environmental variables at spawning study sites at different locations and sites with redds present and absent.

	Average Flow (ft/s)	Min Flow (ft/s)	Max Flow (ft/s)	Average Stream Width (m)	Average Depth (cm)	Average Substrate (cm)	Sites with Redds (Absent)
Howell's Brook	1.39	1.12	1.94	4.3	25.5	5.1	3 (18)
Main West River	1.74	1.20	2.53	9.8	36.5	4.9	22 (6)
Cudmore's	1.98	1.61	2.60	6.4	34.4	5.1	1 (4)
Redds Present	1.7	1.2	2.6	9.5	34.4	4.9	26 (6 Managed Sites)
Redds Absent	1.5	1.1	2.4	5.6	30.0	5.1	29 (24 Managed Sites)

Table 2. Displays study sites that had redds present and absent during redds surveys at each location with number of *Managed Sites* indicated.

	Main West River	Howell's Brook	Cudmore's	Total
Redd Present *(Managed Sites)*	22 (4)	3 (2)	1 (0)	26 (6)
Redds Absent *(Managed Sites)*	7 (6)	18 (14)	4 (4)	29 (24)

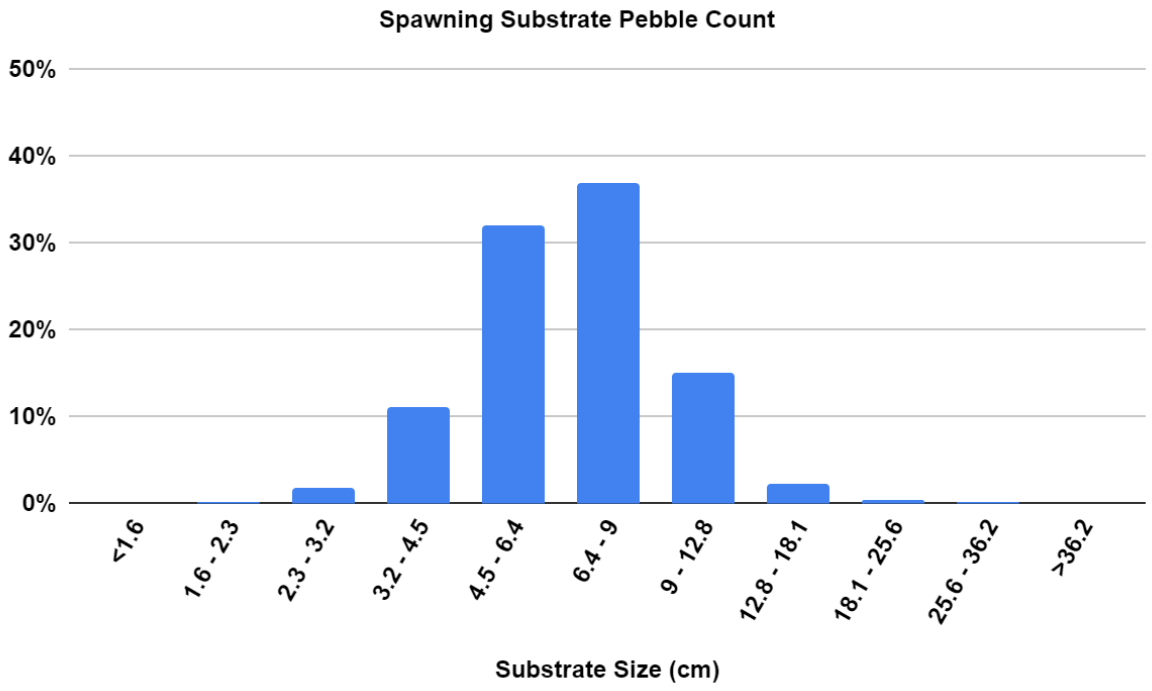
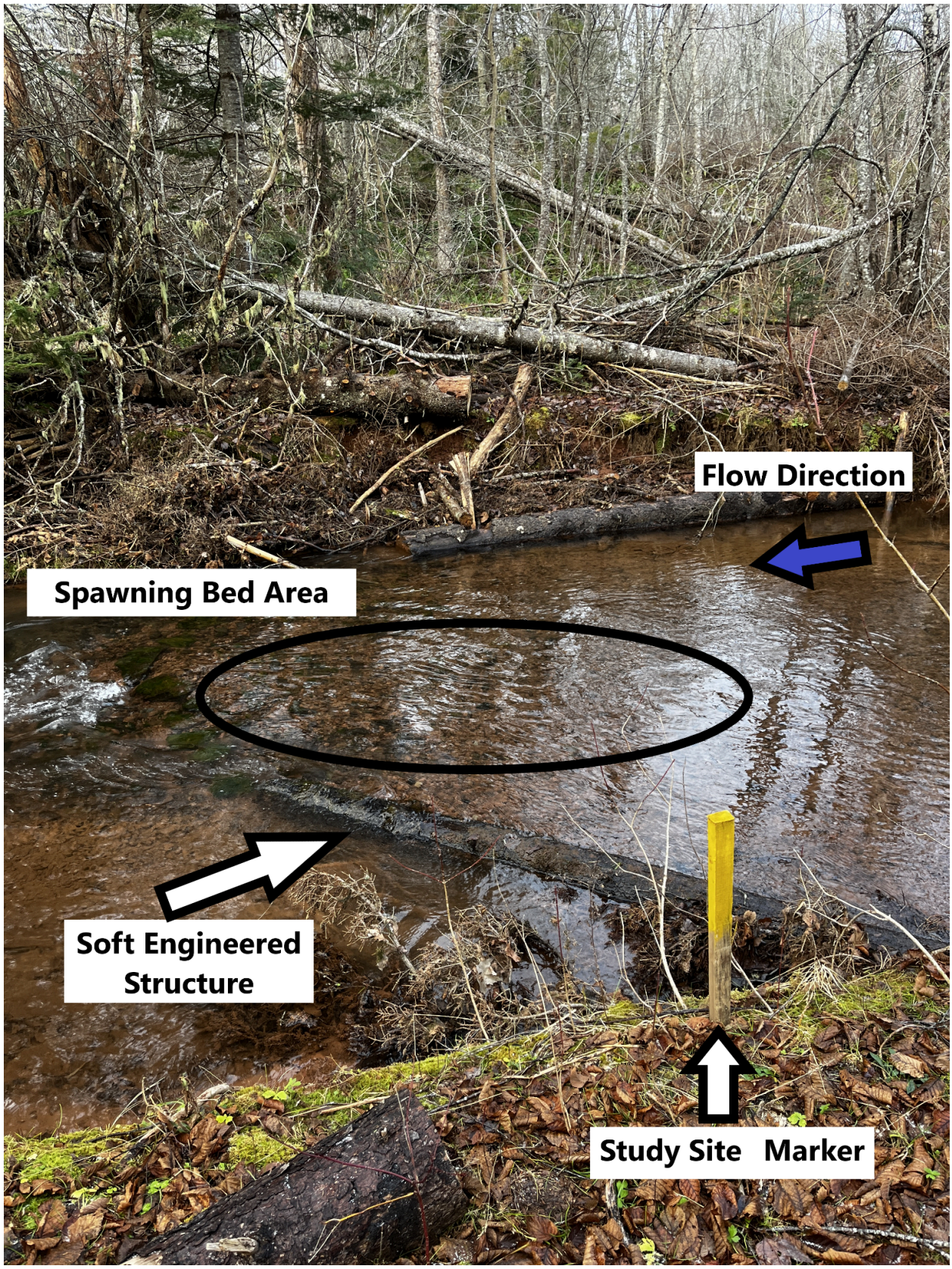


Figure 2. Distribution of different categories of measured spawning substrate across all study sites.

Knowlton Parkman (CQWF) measuring flow velocity at survey site on Howell's Brook

Atlantic salmon redd at a *"Managed Site"* #25 on the main West River. This is an example of a "V" spawning structure CQWF created to provide new spawning habitat.

Atlantic salmon redd at *managed site* #11 on Howell's Brook. This photo represents a typical redd placement within the transition zone between the tail of a pool and crest of a riffle.



Study Site #21 on Howell's Brook. This site is considered "*Managed*" due to the installed soft engineered structure