Green Crab Control Management Trapping and Population Prevalence, Abundance Survey in St Mary's Bay, Newfoundland and Labrador

(Riverhead, Mall Bay, St. Joseph's Beach, Mt. Carmel, and Mitchell's Brook, Holyrood Pond, Cootes Pond, and Colinet)

AQUATIC CONSERVATION INITIATIVE

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Project Objectives

The objective of this contract is to continue to conduct controlled trapping to manage Green Crab populations and also to determine the prevalence, abundance, and seasonal changes of Green Crab (*Carcinus maenas*) in Riverhead, Mall Bay, St. Joseph's Beach, Mt. Carmel, Mitchell's Brook, Holyrood Pond, Cootes Pond, and Colinet NL. Green Crab will be trapped using Fukui traps and will be counted and sexed per trap, and data will be recorded. Caught Green Crab will be killed by freezing for 7 days and disposed of in a landfill after freezing. If Green Crabs are to be transported out of St Mary's Bay for freezing, they will be contained at all times in a locked location (ie. locked truck bed). During trapping efforts, contractors will increase awareness on aquatic invasive species with a focus on Green Crab through outreach events, online media posts, and in-person communications during fieldwork. The information gained from the successful completion of this contract will assist the Department in focusing mitigation efforts in coming years, to control the spread and impact of Green Crab.

Scope of Work

1.1. The contractor may designate trappers to set Fukui Traps in the area of Riverhead, Mall Bay, St. Joseph's Beach, Mt. Carmel, Mitchell's Brook, Holyrood Pond, Cootes Pond, and Colinet. Soak time of traps will be 24 hours, and all Green Crab will be disposed of by freezing following collection, and then discarded in an agreed-upon location (e.g. Robinhood Bay landfill). All bycatch will be returned immediately to the water where removed. There is no catch limit or carapace size restrictions on captured Green Crab, and both females and males may be retained for purposes of disposing as agreed. All of these conditions will be set within the AIS control license issued to the contractor by DFO. The contractor will conduct trapping using 40 Fukui traps provided by Fisheries and Oceans Canada in the areas of Riverhead, Mall Bay, St. Joseph's Beach, Mt. Carmel, Mitchell's Brook, Holyrood Pond, Cootes Pond, and Colinet. Trapping will occur up to twice per month within the scope of time of the contract (July-November 2024), with the following schedule – 2 trap events in August, 2 trap events in September, 2 trap events in October, and 1 trap event in November. During each trap event, a minimum of 30 traps will be set. Trapping will be focused in the Riverhead, Mitchell's Brook, and Mt. Carmel areas where catch per unit was found to be high (>10) in the previous year 2023. The next focal areas will be Mall Bay, Colinet, and St. Joseph's where catch per unit was found to be moderate (>4) in the previous year 2023. Trapping will also continue in Cootes Pond and Holyrood Pond where catch per unit was found to be low (<4) in the previous year 2023 but will be tertiary to the aforementioned sites with higher catch rates. If additional sites are selected based on known habitat for Green Crab, contractors will include these as trapping sites. The traps will be set one day, soaked 24 hours and hauled. The contractor will deem when safe to do so in line with safe weather conditions. Traps should be set ~50-60m apart, and GPS coordinates recorded for each trap (see document on 'Criteria for Collection of Point Data' provided at the end of the Statement of work). The contractor will target areas for trap setting that are known habitat for Green Crab, this includes areas of known eelgrass beds, shellfish beds, barachois, freshwater runoff, muddy bottomed, head of bays, and shallow water. During trapping efforts, field teams will inform interested locals on the impacts of the invasive Green Crab and hand out control trapping licenses to those interested. Staff will organize a field trip with the local school, to teach students about aquatic invasive species in a classroom setting and take the students out to trap green crabs at one of the selected field sites. Contractors will also promote information on aquatic invasive species through social media and website posts.

Green Crab caught will be counted per trap, after the removal of by-catch. Crab will be sexed. All bycatch will be identified and counted. Details of catch site, GPS coordinates, calendar date, bycatch and number of Green Crab contained within must be clearly recorded on the log sheets.

1.2. Contractor will provide any required fishing vessel (not necessary for these locations, as shoreline work is recommended), fuel and bait (cod is recommended, but herring is also acceptable), GPS unit, travel costs (in line with Government of Canada travel directive), and will be responsible for the crushing/freezing and disposal of all caught Green Crab, as predetermined with DFO.

1.3. Contractor will complete a log book of catch (Green Crab and by-catch) provided by Fisheries and Oceans Canada and submit to the AIS Coordinator at DFO St John's (contact Lynn Lush, email: lynn.lush@dfo-mpo.gc.ca) no later than December 31st, 2024.

1.4. Contractor will use equipment that is outlined in the protocol including:

- 40 Fukui Traps, equipped with snaps, bait bucket, rope, and float*
- GPS (please use WGS84 datum for collection – if another is used please record the datum chosen)
- AIS Control License *
- Green Crab and Aquatic Invasive Species Information booklets

DFO will provide this equipment, which will be returned back to DFO at end of contract prior to final payout.

1.5. Trapping will not extend beyond November 30th, 2024.

Project Trapping Locations

Aquatic Conservation Initiative field staff trapped European green crab at 10 different locations in St. Mary's Bay, Newfoundland and Labrador as shown in Figure 1 and Table 1. Trapping locations were selected based on known green crab presence or possible green crab presence based on suitable intertidal habitat. In addition to the 8 trapping sites visited in 2023, we added 2 new exploratory sites for 2024: North Harbour and O'Donnell's, to gain some insight into the abundance present in these areas, and whether it would be beneficial to do some more significant trapping here in future years, in lieu of some of the areas where the population appears to be less dense.

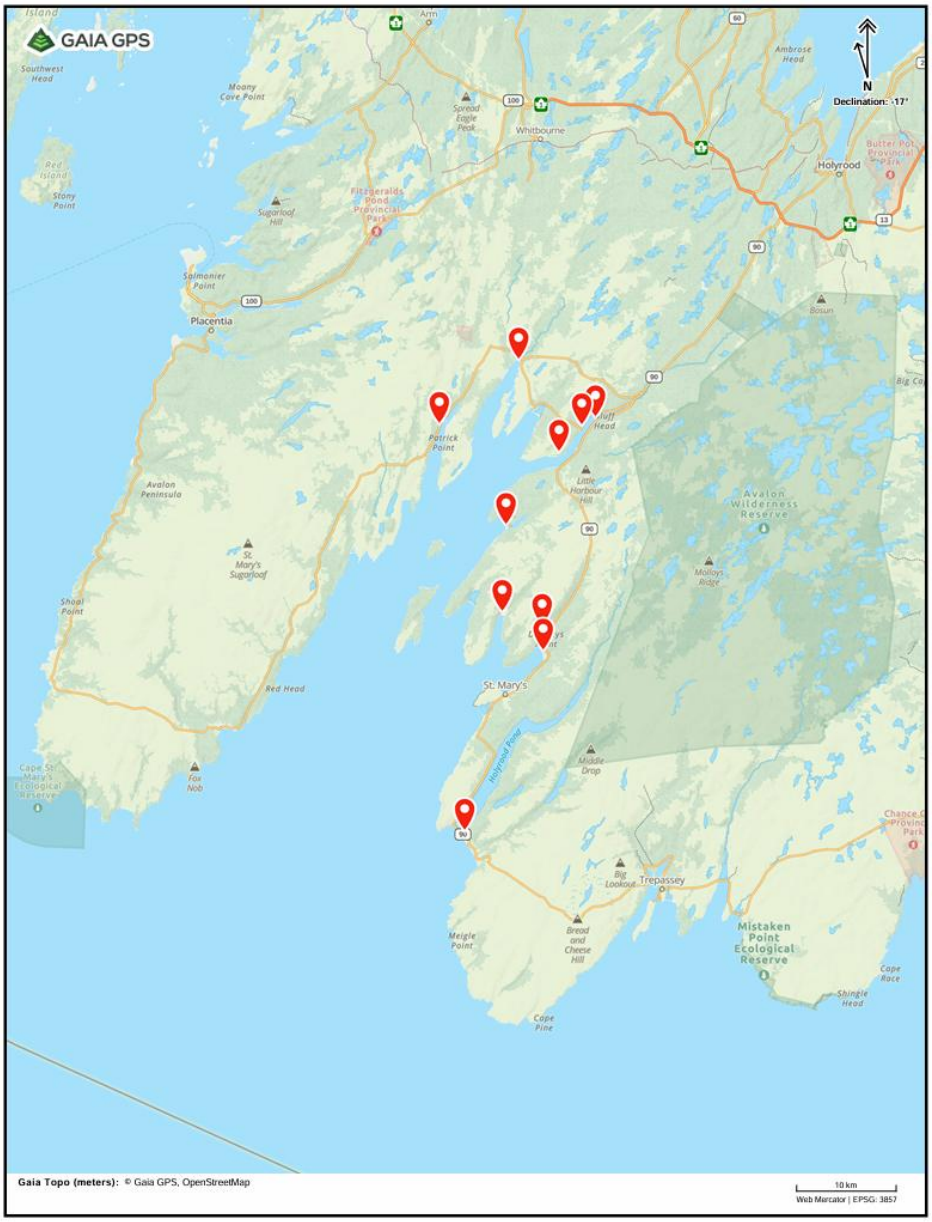

Figure 1. Green Crab Trapping locations in St. Mary's Bay, Newfoundland and Labrador, Canada

Table 1. Green Crab Trapping locations in St. Mary's Bay, Newfoundland and Labrador, Canada

Location Description	Latitude	Longitude	Specific Location	Measures Taken	Threats/Impact
Colinet	47.21128	-53.55604	Colinet	Abundance of Green Crab	Invasive Species
Cootes Pond	46.9521061	-53.51544	Cootes Pond	Abundance of Green Crab	Invasive Species
Holyrood Pond	46.7965664	-53.644658	Holyrood Pond	Abundance of Green Crab	Invasive Species
Mall Bay	46.9854016	-53.573256	Mall Bay	Abundance of Green Crab	Invasive Species
Mitchells Brook	47.1294444	-53.5152778	Mitchells Brook	Abundance of Green Crab	Invasive Species
Mount Carmel	47.1289393	-53.5235319	Mount Carmel	Abundance of Green Crab	Invasive Species
North Harbour	47.1288889	-53.6677777	North Harbour	Abundance of Green Crab	Invasive Species
O'Donnells	47.0691666	-53.5655556	O'Donnells	Abundance of Green Crab	Invasive Species
Riverhead	46.980418	-53.510891	Riverhead	Abundance of Green Crab	Invasive Species
St. Joseph's Beach	47.1188923	-53.511843	St. Joseph's	Abundance of Green Crab	Invasive Species

Green Crab Trapping

Observed Catch Effort

Based on the efforts of European Green Crab removal from St. Mary's Bay area in 2024-2025, Aquatic Conservation Initiative set 334 Fukui traps and removed 4,427 European Green Crab from coastal habitats in St. Mary's Bay. As shown in Table 2, field crews set traps at 10 locations: Colinet, Cootes Pond, Holyrood Pond, Mall Bay, Mitchell's Brook, Mt Carmel, North Harbour, O'Donnells, Riverhead, and St. Joseph's. To observe the efficacy of our trapping efforts, the catch per effort was calculated for each field site by dividing total catch by total traps set. Green Crab population counts as shown in Table 2, indicate that the Riverhead field site was the most successful in the greatest removal of European Green Crab. The Riverhead and Mount Carmel field sites scored the highest in catch per effort at 17.943 and 18.000 crabs per trap respectively. With 1,902 green crabs removed, Riverhead was the field site where efforts were most successful overall. However, the high catch ratio in Mount Carmel indicates that perhaps some additional efforts could be focussed in that area in future years. Lowest and least effective catch was observed at the Holyrood Pond site where no green crab were trapped. For all trapping in St. Mary's Bay, the catch per effort value was 13.254 crabs per trap set.

While catch per effort at O'Donnell's was lower than some of our other trapping locations, the catch was notable due to the catch predominantly being very large males in comparison to those caught elsewhere. While the exact reason for this cannot be determined with any certainty, there are some factors that could have contributed to this skewed size distribution. Including: the sex ratio present in the catch (almost exclusively males were caught here), trapping efforts had not been made by ACI in previous years at this location (so the crabs may have had more time to grow and develop without interference), and the condition of the estuarine environment where they were caught appeared to be still quite healthy, with lush eelgrass beds and productive shellfish beds. It appears that the estuarine ecosystem at O'Donnell's has not yet seen major impacts from green crab presence and should

be continued to be managed for invasive species to prevent green crab populations reaching a threshold population that would dominate the eelgrass beds. A local lobster fisherman chatted with us at the O'Donnell's trapping site and said he has not had any green crab bycatch in his lobster traps set in the area, but thought it was due to the use of wooden traps. Examples of large male green crab sizes are shown in Figure 2 and O'Donnell's eelgrass bed conditions are shown in Figure 3 and 4. To better understand this phenomenon, it could be beneficial to collect data on carapace size in future trapping efforts.

Figure 2. Example of large male green crabs collected from the O'Donnell's trapping site

Figure 3. Productive eelgrass beds at the O'Donnell's trapping site supporting intertidal sponges

Figure 3. Productive eelgrass beds at the O'Donnell's trapping site next to baited Fukui trap

During several trapping events, field staff noted that several green crabs had symmetrical white markings on their carapace. Given the symmetry of the markings, we inferred that this could be a genetic trait shared between related crabs. An example of these white markings is shown in Figure 2. We observed this morphological trait on green crabs removed from the Riverhead, Mitchell's Brook, and St. Joseph's trapping sites. We were unsure if the white markings are of significance to the species however we thought this unusual observation was noteworthy.

Figure 2. Observed symmetrical white markings on the top of green crab shell at the Riverhead trapping site

Table 2. Summary Of Green Crab catch counts, number of traps set, and catch per effort for each trapping location

Location	Total Traps Set	Total Catch	Catch per Effort
Colinet	30	274	9.133
Cootes Pond	5	35	7.000
Holyrood Pond	5	0	0.000
Mall Bay	5	64	12.800
Mitchell's Brook	50	292	5.840
Mt. Carmel	5	90	18.000
North Harbour	5	23	4.600
O'Donnells	42	133	3.167
Riverhead	106	1902	17.943
St. Joseph's	101	1614	15.980
All Locations	**334**	**4427**	**13.254**

Observed Catch Sex Ratio

During our efforts of European Green Crab removal from St. Mary's Bay all trapped green crabs were sexed by observing the morphology of the telson. For all trapping sites, a breakdown of sex ratios is shown in Table 3. At all trapping sites, more males were trapped than females. Across all trapping sites, 1,414 females and 3,013 males were removed by field staff from the St. Mary's Bay area. A male dominated catch could be due to sex ratio differences in the population or because males are more likely to enter the trap due to physiological and metabolic differences between sexes at the time of trapping. Specific abundance values for males and females collected during each trapping trip can be found documented in the raw data spreadsheet, titled *ACI Green Crab Catch Data 2024*.

Table 3. Green Crab Sex Ratios by Location

Location	Females	Males
Colinet	61	213
Coote's Pond	13	22
Holyrood Pond	0	0
Mall Bay	14	50
Mitchell's Brook	72	220
Mt Carmel	28	62
North Harbour	1	22
O'Donnells	1	132
Riverhead	907	995
St. Josephs	317	1297
All locations	**1414**	**3013**

By-Catch

During controlled trapping efforts for European green crab, field staff documented all by-catch caught in the Fukui traps. Several species were identified as by-catch including Rock crab, American eel, cunner, and unknown species of flounder, sculpin, and hake. A comprehensive list of all by-catch is noted in Table 4. All rock crabs that were caught as by-catch were sexed and an example photo of a rock crab is shown in Figure 4. At Riverhead and Mall Bay trapping locations, on trap pulls field staff noted that bait cups had been inundated with many marine amphipods as shown in Figure 5. In one instance, the bait cup was entirely full with the small amphipods at Mall Bay. Field staff were not able to identify the species.

Table 4. Summary of by-catch counts for each trapping location

Location	Rock Crab	Sculpin	American Eel	Hake	Flounder	Cunner	Northern Seastar
Colinet	1	1	1	1	1	0	0
Cootes	0	0	0	0	0	0	0

Pond							
Holyrood Pond	0	0	0	0	0	0	0
Mall Bay	1 male, 1 female	0	0	0	0	0	0
Mitchell's Brook	1	0	0	0	0	0	1
Mt. Carmel	0	0	0	0	0	0	0
North Harbour	6	0	0	0	a0	1	0
O'Donnells	8 Male, 1 female	0	0	0	0	0	0
Riverhead	5 male	3	0	2	0	1	0
St. Joseph's	33 male, 38 female	0	0	2	0	11	0
All Locations	**95**	**4**	**1**	**5**	**1**	**14**	**1**

Figure 4. Rock Crab (*Cancer irrotus*) by-catch at St. Joseph's trapping site

Figure 5. Unidentified marine amphipods found in bait cups at Mall Bay trapping site

Other Documented Aquatic Invasive Species

During controlled trapping efforts for European green crab, field staff were alerted that there have been accounts of the invasive species oyster thief (*Codium fragile* ssp. *fragile*) in the Riverhead area. Given the known presence of oyster thief in the area, field staff paid extra attention to the high tide mark and in the coastal waters of all trapping locations in St. Mary's Bay. Field staff only found oyster thief at the Riverhead site location washed ashore at the high tide mark (46.975, -53.521). Specimen example is shown in Figure 6**.** Specimens were returned to the AIS DFO team to confirm identification and other samples were destroyed.

Figure 6. Oyster thief (*Codium fragile* ssp. *fragile*) specimen found washed ashore at the high tide mark (46.975, -53.521)

Disposal of Green Crab

Green Crabs transported out of St Mary's Bay for freezing were contained at all times in a locked location (ie. locked truck bed). All caught green crab were killed by freezing for 7 days and disposed of at Robin Hood Bay Landfill in St. John's, Newfoundland and Labrador. Following the last trapping event, field staff attempted to dispose of green crab catch at Robin Hood Bay landfill however landfill staff stated that a permit was required to dispose of invasive species. In this instance, green crab were disposed of directly at the Northwest Atlantic Fisheries Centre after contacting the Aquatic Invasive Species Team. In future, a disposal permit will need to be included into the budget or included in DFO offered equipment with traps, license, and outreach materials etc. Alternatively, all catch could be returned to the Northwest Atlantic Fisheries Centre for disposal instead of the Robin Hood Bay Landfill.

Communications

Aquatic Conservation Initiative led a successful outreach and communications portion of the project. In total 12 communication actions were taken through several media forms ie. in-person presentations, distribution of print media, website post, and through social media as shown in Table 4. An example of an educational social media post that demonstrates key factors for identifying green crab is shown below in Figure 7. During trapping efforts, field staff also discussed aquatic invasive species, green crab, and available trapping licenses to locals who stopped to chat with staff. Staff chatted with locals at the St. Joseph's, O'Donnells, North Harbour, and Colinet trapping sites. Locals did not have interest in trapping crabs through a controlled trapping license, and were most interested in population size in the area and what removed green crabs were used for. Unfortunately, we were unable to get in contact with any teachers at St. Catherine's Academy in Mount Carmel this year to bring students into the field to trap green crabs as done in previous years.

Table 4. Record of Communications

Type of Communication (e.g. media/public event, newspaper, newsletter, magazine article, blog)	Communication Details (e.g. title, distribution size, number of participants)	Date of Communication	Web Link (if not posted to the Web, submit a copy with report)
Presentation	Marine Institute Marine Environmental Tech Student Presentation	November 20, 2024	https://docs.google.com/presentation/d/1iVmNQdlNF-otbJ8NGG9Dkt-Q7QSRzVcd/edit?usp=sharing&ouid=111053804920627257026&rtpof=true&sd=true
Presentation	ENGO Caucus Presentation	November 25, 2024	https://docs.google.com/presentation/d/1iVmNQdlNF-otbJ8NGG9Dkt-Q7QSRzVcd/edit?usp=sharing&ouid=111053804920627257026&rtpof=true&sd=true
Presentation	Memorial University BIology Student Presentation	November 28, 2024	https://docs.google.com/presentation/d/1iVmNQdlNF-otbJ8NGG9Dkt-Q7QSRzVcd/edit?usp=sharing&ouid=111053804920627257026&rtpof=true&sd=true
Print Media	Dropped DFO produced "Stop Aquatic Invasive Species" infographic at Mt. Carmel Post Office to be distributed to St. Mary's Bay community members	November 14. 2024	N/A
Website	Green Crab Counter Banner	December 12, 2024	https://aci-nl.ca/
Website	Green Crab Project News Post	December 12, 2024	https://aci-nl.ca/2024/12/12/tot

			al-green-crab-catch-is-in-for-2024/
Social Media	Project Announcement Distribution: *Instagram* 167 views, 75 reach, 119 impressions, 12 likes *Facebook* 719 reach, 740 impressions, 12 likes, 3 shares	August 29, 2024	https://www.instagram.com/p/C_Q4VTgNO7t/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA== https://www.facebook.com/share/p/1XuHuQrbaL/
Social Media	Green Crab Identification Distribution: *Instagram* 246 views, 79 reach, 200 impressions, 19 likes *Facebook* 531 reach, 561 impressions, 8 likes, 3 shares	September 20, 2024	https://www.instagram.com/p/DAJB6QcN__e/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA== https://www.facebook.com/share/p/1XpP2VveFP/
Social Media	Sexing Green Crab Distribution: *Instagram* 123 views, 72 reach, 90 impressions, 9 likes *Facebook* 269 views, 151 reach, 160 impressions, 6 likes, 1 share	September 23, 2024	https://www.instagram.com/p/DAQg7lriCqM/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA== https://www.facebook.com/share/p/1SaWXXHE72/
Social Media	Green Crab Identification Distribution: *Instagram* 114 views, 73 reach, 86 impressions, 17 likes, 1 comment *Facebook* 111 views, 83 reach, 85 impressions, 3 likes	October 25, 2024	https://www.instagram.com/p/DBjmWMGuyTw/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA== https://www.facebook.com/share/p/1Dkr77DCC8/
Social Media	Green Crab Halloween Post Distribution: *Instagram* 259 views, 80 reach, 223 impressions, 9 likes *Facebook* 665 views, 411 reach, 415 impressions, 6 likes, 1 share	October 31, 2024	https://www.instagram.com/p/DBy-SGtMd5b/?utm_source=ig_web_copy_link&igsh=MzRlODBiNWFlZA== https://www.facebook.com/share/p/15Xgsrs1k9/

Social Media	Project Update Distribution: *Instagram* 313 views, 228 reach, 268 impressions, 12 likes, 1 comment, 1 share *Facebook* *798* views, 482 reach, 482 impressions, 6 likes, 4 shares	December 12, 2024	https://www.instagram.com/p/DDfV3sOu6jm/?img_index=1 https://www.facebook.com/share/p/1GW2mKsvj5/

Figure 7. Example of educational social media post on how to identify green crab posted on September 20, 2024

Project Outcomes

As discussed above, Aquatic Conservation Initiative completed monitoring and controlled trapping efforts of the invasive European green crab at several locations in St. Mary's Bay, Newfoundland and Labrador. This is the third year we have completed trapping in the region and in comparison to previous years, for the 2024 trapping season we removed the most amount of green crab of the three years (4427 total). In 2022 we removed 2,438 green crabs and in 2023 we removed 3,200 green crabs. The increase of catch could be the result of several factors including a growing population of green crab in St. Mary's Bay, improved trapping efforts with experience, increased trap setting from the initial year of trapping efforts, or other unknown factors. Given the counts of green crab recorded this year, the population of green crab in St. Mary's Bay should be continued to be managed into future years to prevent ecological destruction of valuable habitats such as eel grass and shellfish beds, and limit inter-species competition between native crustaceans.

As noted above, oyster thief (*Codium fragile* ssp. *fragile)* an aquatic invasive species was observed at the Riverhead trapping site. Therefore, surveying for oyster thief should be included in future invasive green crab monitoring and controlled trapping efforts in St. Mary's Bay.

Aquatic Conservation Initiative hosted several outreach events, online media posts, and discussed aquatic invasive species through in-person communications during fieldwork. We connected with undergraduate students, researchers, ENGOs, and several departments within Fisheries and Oceans Canada at the ENGO Caucus meeting and undergraduate presentations. Social media was used to highlight project updates but also provide educational information on what an invasive species is, why green crabs are invasive, the impacts green crabs have on coastal ecosystems, and how to identify green crab. The website posts detailed project updates such as the launch of the project and final results.