

At-Sea Performance Evaluation of Lobster Trap Runners



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At-Sea Performance Evaluation of Lobster Trap Runners

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Submitted to:

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and

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ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

1.1 *Background*

R.A.P. Technologies Inc. is a green start-up company. At the core of its business strategy is to utilize materials originally destined for landfills, to produce robust parts for industrial sales. Since its formation in July of 2015, R.A.P. has faced many challenges, but refuses to make their products anywhere other than New Brunswick. Their goal is to continue finding innovative solutions for aquaculture and other industries, using recycled materials and environmentally responsible practices. The company presently employs 8 people on a full-time basis.

Sample products have been developed and are being used on a small scale in the Atlantic Canada lobster fishery. The original prototype which used only rubber, couldn't be produced hard enough to withstand the rigors of lobster fishing. Building on the original design, an encapsulated steel bar also fell short of the company's quality standards. The prototype was subsequently redesigned and the current version of the runner, which is now poised for full production, is made of steel encapsulated in recycled rubber.

This prototype however has yet to be performance tested. The company has engaged with the Centre for Sustainable Aquatic Resources to conduct performance trials on the project to evaluate the stability and orientation of the traps equipped with the runners, as well as look at the effects of wear and tear on the integrity of the runners.

The product is considered a unique design, and a patent search ensures that there is nothing similar to the product currently in the marketplace. Market potential in Canada is significant given the number of lobster traps currently in use in Atlantic Canada and Quebec. Further, comparable fisheries in United States (New England, California), Scandinavia, Western Europe, and the United Kingdom also present opportunities for export.

Before proceeding to large-scale commercial production and sales of the revised prototype, the company would like to have independent performance testing conducted on the runners. This will help the company to determine if the stability and orientation of the traps are impacted by the weighted runners; and to determine the effect of impact loads/breaking forces on the traps given they are routinely crashed against the sides and decks of boats during standard fishing operations.

1.2 Benefit to Industry or Client

Runners on lobster traps are subject to severe wear and tear based on the nature of handling and deploying the traps from a fishing vessel, reducing their shelf life as a result. Traditional wooden traps, and modernized wire mesh traps typically have either wooden, plastic or no runners.

Using only recycled premium grade industrial commercial tire rubber, in a patented process that completely encapsulates steel, this new product provides significantly higher strength and durability than traditional runners. The RAP runner not only lowers the ballast, causing the trap to always land in the fishing position, but it also prevents wear and tear on equipment and allows a very strong foundation for a lobster trap to be built on. As a cost-saving measure, the proposed runners can also be transferred from one trap to the next, thus reducing long term costs.

With the new material, the runner becomes impervious to rot, prevents wear and tear on boats and equipment while also making them easier and safer to handle by workers. All of these factors collectively increase fishing efficiency and reduces the damage to traps while recycling waste materials otherwise destined for landfill.

1.3 Innovation

Traditional wire traps have concrete for ballast, wooden traps either have concrete or rocks. These materials add significant weight to each trap. As an example, in the Maritimes, a typical wire lobster trap with concrete ballast weighs about 48 lbs (22 kg) in air. Concrete, while often viewed as convenient as it can be molded flat and takes less space than a rock in a mesh sack, it is porous, and tends to lose its weight when placed in water due to tiny air bubbles contained within (i.e., less dense), thus lessening its effectiveness as a ballast. Furthermore, concrete has a relatively short lifespan, breaking down and needing replacement after a few seasons. Rocks used as ballast may not lose weight underwater but are cumbersome and heavy.

Some traditional wooden traps, and modernized wire mesh traps, may also have either wooden or plastic runners to make sliding on the gunnels of vessels easier when deploying or retrieving. Runners on lobster traps are subject to severe wear and tear based on the nature of handling and deploying the traps from a fishing vessel, reducing their shelf life as a result.

R.A.P Technologies' novel runner system serves the purpose of both ballast and runner for easier sliding, all in one system. Using only recycled premium grade industrial commercial tire rubber, in a patented process that completely encapsulates the steel, this new product provides significantly higher strength and durability than traditional runners. The RAP runner not only lowers the ballast, causing the trap to always land in the fishing position, but it also prevents wear and tear on equipment and allows for a very strong foundation for a lobster trap to be built on. As a cost-saving measure, the proposed runners can also be transferred from one trap to the next, thus reducing long term costs.

With the new material, the runner becomes impervious to rot, prevents wear and tear on boats and equipment while also making them easier and safer to handle by workers. All of these factors collectively increase fishing efficiency and reduces the damage to traps while recycling waste materials otherwise destined for landfill. The materials are non-toxic, confirmed by independent testing.

1.4 Project Objectives

This project had four key objectives that focus on assessing the functionality of the runners installed on both wooden and wire traps. A local harvester was used to test out the traps during the 2021 commercial lobster season to determine their success and ease of use. They were tended at all times; no bait was used and no lobsters were captured/landed.

The four primary objectives included:

1. *Stability and Orientation Assessment:* the company would like to determine if the addition and positioning of the weighted rubber runners on the trap has an impact on the stability and orientation of the traps during sinking and settling on the seabed; and whether this is impacted by the current or water flow. The goal is to ensure the inclusion/positioning of the runner does not cause the traps to tip over and potentially block the entrance to the traps during deployment and settling on the seabed.
2. *Side by Side Comparison with Traditional Traps:* R.A.P. Technologies Inc. would like to assess how this prototype compares to the use of a traditional trap using the current concrete setup as ballast.
3. *Trap Drift:* to determine the amount of drift that the trap is encountering during deployment as compared to the traditional setup. When harvesters deploy a trap on the

grounds they do not want it to drift too much and potentially not land in the desired fishing location.

4. *Health and Safety Analysis by WorkPlace NL.*

- Observe, from an ergonomics lens, workers conducting the tasks of 1) deploying traps and 2) retrieving traps. The purpose is to provide an opinion whether a worker's musculoskeletal injury (MSI) risk might be impacted by handling traps installed with the new runners versus the traditional styles, for both tasks. Analysis was observational and mostly qualitative.
- Handling of both the traditional wire traps and the wooden traps weighted with concrete, and using traditional runners were compared against handling of traps installed with the new runners. Observations were mostly focused on the following major MSI risk factors: awkward postures, forceful exertions, local contact stresses, repetitive movements, and sustained/static postures.

2.0 METHODOLOGY

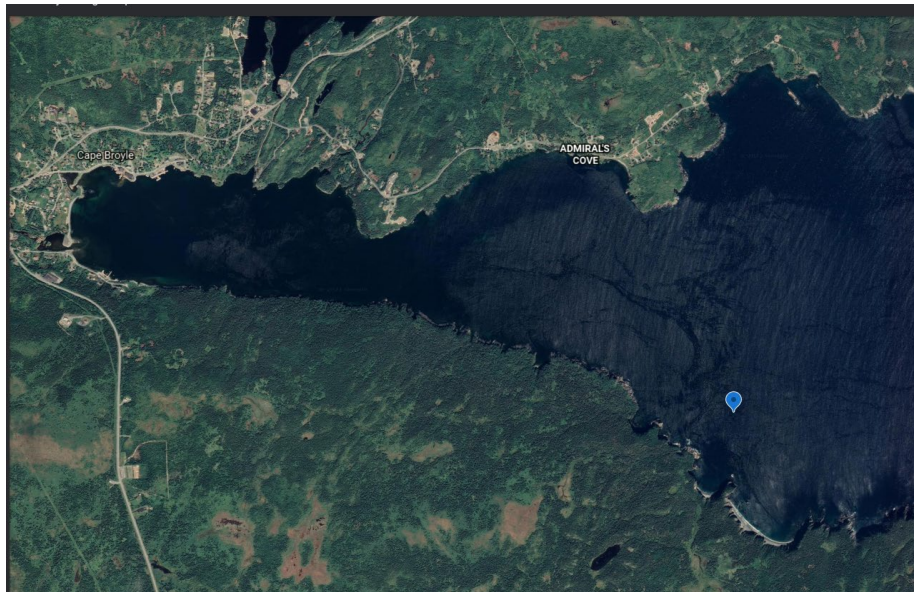


Figure 1: Assessment Location; Cape Broyle, NL

A series of five performance tests were conducted during this project. The tests included:

1. Stability and Orientation Assessment

A series of trap deployments were conducted to verify whether the weight and positioning of the rubber runners act as a ballast and enable the traps to sink and settle on the seabed in its proper orientation. The tests determined if the weight and positioning of the rubber runners impact settling orientation thus creating a risk that the traps will tip over and block the entrance to the traps. As part of the experiment, a series of trap deployments were conducted from the deck of the vessel equipped with video equipment to capture how the lobster traps settle on the seabed. The traps were thrown repeatedly into the water at different angles to see if either of these variables impact sinking and settling.

2. Side by Side Comparison with Traditional Traps

Each experimental trap along with a traditional trap was deployed while video was recorded to capture the final orientation of the trap when it lands on the sea floor. The traps were thrown repeatedly into the water at different angles to see if either of these variables impact sinking and settling.

3. Trap Drift

To test trap drift the coordinates of the deployment were recorded during the launch. Once the trap settles on the seafloor it was recovered using the attached tether. New trap coordinates were recorded at this time and plotted against the deployment coordinates. From this information the total distance the trap drifted was calculated. This was conducted at different depths and for both the control trap and the experimental one. By conducting a series of these tests, the research team was able to determine if the experimental traps perform differently than traditional traps.

4. Runner Durability

Qualitative assessment of deploying and retrieving to evaluate runners' ease of sliding on boat gunnels and durability. Previous prototypes found the ballast 'gummy' and tended not to slide well.

5. Ease of Use Assessment

Health and safety of harvesters is of great concern in the fishery. Each year, there are numerous injuries reported at great costs to operators. However, hidden from acute injury reporting are long term impacts that operations may have on the health and safety of crew members. Heavy

gear, lifting and repetitive twisting may lead to long term injuries not often reported until too late. It was important to this project to determine whether the new runner system makes the lobster traps easier to use by the harvester. One would presume less weight equals easier handling. As part of the runner assessment, 'ease-of-use' was qualitatively assessed during the course of the deployments and retrievals by Workplace NL.

3.0 RESULTS

3.1 *Stability and Orientation Assessment*

All tests were completed using full size traps. There were three different styles of traps tested (Figure 2) each having a traditional setup with wooden runners/concrete ballast and the same trap using the experimental RAP runners.

- All deployments were made using the traditional trap followed by the experiment trap and deployed by the harvester in two different orientations. The traps were tested with runners down and on its side.
- Each trap was weighed dry and again wet once experiment was complete (Table 1)
- Every configuration was repeated five times and the results recorded (video)
- Table 2 outlines the results of each deployment of the lobster traps using both the traditional and the experimental runners. Most of the deployments observed traps landing in the proper fishing orientation except for the large wire trap with traditional ballast configuration. These traps failed 50% of the time landing in a position that would either block the entrance to the traps or the trap would land upside down (Refer to video to examine the final fishing position). This could simply be explained by misplacement of ballast weight by the manufacturer of these traps.



Figure 2: Wooden and Wire Lobster Traps

Table 1: Trap Weight

Trap Style	Dry Weight (kgs)	Wet Weight (kgs)
Wooden Trap Traditional	39.5	45
Wooden Trap RAP	30	34.5
Wire Trap Large Traditional	21.5	23
Wire Trap Large RAP	20	20.5
Wire Trap Small Traditional	22.5	23
Wire Trap Small RAP	18.5	19

Table 2: Trap Deployment Final Orientation

Trap Style	Run #	Pass	Fail
Wooden Trap Traditional	1	X	
	2	X	
	3	X	
	4	X	
	5	X	
Wooden Trap RAP	1	X	
	2	X	
	3	X	

	4	X	
	5	X	
	SIDE	X	
Wire Trap Large Traditional	1		X
	2	X	
	3		X
	4		
	5		X
	SIDE		X
Wire Trap Large RAP	1	X	
	2	X	
	3	X	
	4	X	
	5		X
Wire Trap Small Traditional	1	X	
	2	X	
	3	X	
	4	X	
	5	X	
	SIDE	X	
Wire Trap Small RAP	1	X	
	2	X	
	3	X	
	4	X	
	5	X	
	SIDE	X	

3.2 Trap Drift

To test trap drift, the GPS coordinates of the deployment were recorded during the launch. Once the trap settled on the seafloor, it was recovered using the attached tether. New trap GPS coordinates were recorded at this time and plotted against the deployment coordinates. From this information the total distance the trap drifted was calculated. Table 3 shows the average drift (in meters) recorded during the experiment. In all scenarios the traps with the experimental RAP runners drifted further than the traditional traps. The wooden trap with RAP runners drifted 19.7% further than the traditional trap. The large wire trap with RAP runners drifted 20.7% further than the traditional trap while the small wire trap with RAP runners drifted 45.6% further than the traditional trap.

Table 3: Trap Drift

Trap Style	Average Drift (m)
Wooden Trap RAP Runner	7.67
Wooden Trap Traditional Runner	6.16
Wire Trap Small RAP Runner	8.96
Wire Trap Small Traditional	4.87
Wire Trap Large Traditional	7.37
Wire Trap Large RAP Runner	9.29

3.3 Runner Durability

During the testing of the traps, general observations were made with regards to the ease of use of the traps. The harvester was asked during the moving and deployment of the traps how easy he found handling both traps. The consensus is that the traps with the RAP runners were much lighter and easier to handle but while dragging them on the aluminum rails that they would bite on and make it hard to slide them overboard. The same was happening during retrieval of the traps making them harder to pull aboard the boat. The rubber runners would however hold well in place when unloading the lobsters and rebaiting the trap. This seems to only occur when moving the traps along the aluminum rails and not when sliding on the fiberglass floor.

3.4 Ease of Use Assessment

Refer to Appendix A for complete report from WorkPlaceNL

4. SUMMARY AND RECOMMENDATIONS

The overall project was deemed a success as the client was able to achieve their goals. All measurements and adjustments were made to the new runner design and it performed well during testing. Once again, the only observation for improvement that was made by the research team and the harvester was the sticky nature of the runner. Although this would be a favorable characteristic during the stacking of the traps onboard the boat, it made it difficult to launch the trap as it gripped the gunnel of the boat. The harvester noted they couldn't push the trap away from the boat with the same ease of the wooden runner.

Please refer to the following link:

<https://www.mi.mun.ca/filesender/?s=download&token=c33ea330-bebf-e28c-8b5d-384063421913> for full access to videos and pictures taken during testing. This link is valid until June 24th, 2021.

It is recommended that further testing be done on future renditions and modifications of the RAP runner. If the hardness on the runner can be increased making them less “sticky” it would be of interest to test them in a new sea trial experiment. Comparative fishing experiments should also be carried-out to document whether the runners have any negative effect on the catch rates or size-selectivity of lobster. This data would be useful to the client in any future promotional material.

5. ACKNOWLEDGEMENTS

The Marine Institute and the client (R.A.P. Technologies) would like to acknowledge the financial contribution of the Canadian Centre for Fisheries Innovation (CCFI) and Damien Stratton for the use of his vessel the *F/V Kitty Phonse*.

APPENDIX A



Health | Safety | Compensation

At-Sea Evaluation of Lobster Trap Runners
Ergonomic Assessment Report

For: Canadian Centre for Fisheries Innovation

Individual Interviewed: Damien Stratton, Harvester/Worker

Date of Assessment: June 2, 2021

Date of Report: June 14, 2021

Assessment and Report Completed By: Cherylee Osborne, WorkplaceNL

On June 2, 2021, WorkplaceNL participated in an at-sea observation of lobster trap deployment and retrieval aboard a fishing vessel off Cape Broyle, Newfoundland and Labrador. WorkplaceNL was tasked with comparing the musculoskeletal injury (MSI) risk to workers of deploying and retrieving traps designed with R.A.P. Technologies Inc. runners against traditional traps with concrete setup as ballast. The purpose was not to provide a level of risk for each task; rather, to determine if the use of R.A.P. Technologies runners presented a difference in risk compared to traditional concrete as ballast, and if so, whether the risk was higher or lower.

During the visit it was identified by Marine Institute that for the task of retrieving traps, only the hydraulics assistance method needed to be assessed; therefore, assessment of the complete manual retrieval method did not take place.

The assessment approach taken combined task and postural analysis through visual observation, measurements, photographs and videos with qualitative data through discussions with the worker. Videos and photographs allowed for post-visit postural analysis using the Rapid Upper Limb Assessment (RULA) tool. The weights of each trap were measured on-site using a weigh scale both pre-deployment into the water and post-retrieval. This assessment focuses on the following MSI risk factors, which are the most relevant to these tasks: awkward postures, forceful exertions, local contact stresses, repetitive movements, and sustained postures.

Comparisons of MSI risk in the use of R.A.P. runners versus traditional concrete for ballast were performed on three styles of lobster traps:

- 1) wooden traps;
- 2) wire traps, large; and,
- 3) wire traps, small.

For each style, one trap was equipped with R.A.P. Technologies runners and a second trap, identical in size and shape, was equipped with concrete for ballast. There were six traps in total.

For comparative purposes, only one worker completed the tasks. This allowed for consistency in anthropometrics, which otherwise might have impacted postural angles between one individual and another.

Findings

Discussions were had with the worker to assist in recognizing and evaluating risk factors for MSI. Feedback from the worker (qualitative data) that was considered in the overall evaluation of MSI risk are provided below.

- When attempting to slide the large wire trap with R.A.P. Technologies runners up aluminum railing from the back part of the vessel toward the front, the worker commented “Look, no slide, at all.” The assessor also noted the sound of squeaking as this action was demonstrated.

- In comparison to the wooden traps with R.A.P. Technologies runners, when asked: “How does the *wire* trap feel with the rubber (R.A.P. Technologies runner)?” the worker responded, “Pretty good, it’s still sticky but it’s not so bad, as heavy.”
- When asked for an opinion on the potential ease of use of the R.A.P. Technologies runners if the company were to address the stickiness of the rubber, the worker commented that these would be a lot easier to use compared to concrete given their lighter weight.
- Immediately following deployment of the large wire trap with concrete as ballast and wooden runners, in comparison to the traps with R.A.P. Technologies runners the worker commented, “A lot easier, they kind of wants to go out theirself as soon as they starts going.”

For each MSI risk factor assessed, the following findings were made.

Forceful exertions

Trap weight:

Wooden traps

	Pre-deployment (dry) – kilograms (kg)	Post-retrieval (wet) – kilograms (kg)
R.A.P. Technologies Runners	30	34.5
Concrete for ballast	39.5	45

Wire traps, large

	Pre-deployment (dry) – kilograms (kg)	Post-retrieval (wet) – kilograms (kg)
R.A.P. Technologies Runners	20	20.5
Concrete for ballast	21.5	23

Wire traps, small

	Pre-deployment (dry) – kilograms (kg)	Post-retrieval (wet) – kilograms (kg)
R.A.P. Technologies Runners	18.5	19
Concrete for ballast	22.5	23

For all trap styles, those equipped with R.A.P. Technologies runners weighed less compared to the same style trap equipped with concrete ballast, both pre-deployment (dry) and post-retrieval (wet). In respects to MSI risk, the higher the weight of a load lifted, the higher the risk of injury to the worker. From a load weight perspective, then, the lifting of traps equipped with R.A.P. Technologies runners presents a reduced risk of injury when compared to traps with concrete for ballast.

The worker's method of gripping and handling each style of trap did not appear to be altered in any way between the use of R.A.P. Technologies runners and the use of concrete.

When considering the forces required to horizontally push and pull the traps with R.A.P. Technologies runners across the aluminum deck railing, based on worker feedback it appears there is an increased amount of friction and effort required to push and pull the traps with R.A.P. Technologies runners compared to those with concrete for ballast. Push forces are required to clear the trap from the railing during deployment and pull forces are required to slide the trap across the railing during retrieval. Without the use of a force guage to quantitatively measure the push/pull forces, it is difficult to say for certain whether the forces are higher or lower with the R.A.P. Technologies runners when considering both the increased friction from the rubber and the decreased load weight. Subjectively, however, the worker expressed that the traps with concrete for ballast and wooden runners are a lot easier to push off compared to those with the R.A.P. Technologies runners.

Another consideration in regards to pull forces is that required to initially pull the traps vertically from the ocean floor for the short period before hydraulics is used. Traps equipped with concrete for ballast have reduced surface area with which water can flow through compared to traps with R.A.P. Technologies runners. Considering this in addition to the fact that traps with concrete also weigh more, it can be deduced that vertical pull forces are higher using concrete compared to R.A.P. Technologies runners.

The overall consensus from this assessment is that if R.A.P. Technologies Inc. were to reduce the stickiness of the rubber used for the runners, the resulting reduction in friction across the aluminum deck railing in combination with their lesser weight would reduce the forceful exertions required by the worker compared to using concrete, and, therefore, would reduce the worker's MSI risk.

Awkward Postures

Task 1: Trap deployment

The most awkward posture during deployment, for all styles of traps, is the position taken just as the trap is released from the hands, as depicted below. The more awkward the posture, the higher the risk of MSI.

Wooden Trap with R.A.P. Technologies Runners



Wooden Trap with Concrete



When comparing postures using wooden traps, the upper arm position is more awkward when using the R.A.P. Technologies runners - shoulder angle is greater than 90 degrees compared to 90 degrees when using concrete. The same is true for the trunk position – the trunk is more awkward using the R.A.P. Technologies runners. This may have to do with the increased friction between the rubber runners and aluminum rail, resulting in the worker holding onto the trap until it has fully cleared the rail to prevent it from striking the vessel. It is believed that reducing the stickiness of the rubber would reduce such friction and improve momentum, thereby allowing the worker to let go of the trap earlier and reduce the awkwardness of the upper arm and trunk postures.

Wire Trap with R.A.P. Technologies Runners, Large



Wire Trap with Concrete, Large



With the large wired traps, there was no significant difference in postures observed between the use of R.A.P. Technologies runners and concrete for ballast.

Wire Trap with R.A.P. Technologies Runners, Small



Wire Trap with Concrete, Small



The worker's upper arm position and trunk position are more awkward when using small wired traps with R.A.P. Technologies runners compared to the same style trap with concrete for ballast.

It is the opinion of the assessor that if R.A.P. Technologies Inc. reduced the stickiness of the rubber used for the runners, the worker's upper arm and trunk postures would improve and be comparable to the postures used when working with traps equipped with concrete for the task of deployment.

Task 2: Trap retrieval

For all three styles of traps (wooden, wired large and wired small), no significant difference in postures were observed between the use of R.A.P. Technologies runners and the use of concrete for ballast during the task of retrieving traps.

Local contact stresses

When lifting traps, there may be a slight reduction in MSI risk from contact stress in the fingers and hands when lifting traps with R.A.P. Technologies runners compared to traps with concrete for ballast due to the lighter weight. On the contrary, contact stress in the fingers and hands may be increased when pushing and pulling traps with R.A.P. Technologies runners horizontally across the deck railing compared to the traps with concrete for ballast due to the stickiness of the rubber.

Repetitive movements

There was no difference observed in repetitiveness of tasks between using traps with R.A.P. Technologies runners and traps with concrete for ballast.

Sustained postures

There was no difference observed in sustained muscle activity between using traps with R.A.P. Technologies runners and traps with concrete for ballast.

Conclusion

Question 1:

For the task of deploying traps, does there appear to be any difference in MSI risk to workers in handling traps installed with R.A.P. Technologies runners versus traps with concrete for ballast? If yes, does the risk appear to be higher or lower?

Answer: Subjectively (worker feedback) and based on visual observation, there appears to be increased effort required to horizontally push (deploy) traps with R.A.P. Technologies runners across aluminum deck railing compared to traps with concrete as ballast (despite the reduced load weight) due to the stickiness of the rubber. Therefore, there appears to be increased MSI risk using R.A.P. Technologies runners for the task of deployment using the present runner prototype. However, it was noted by the representative of Marine Institute that R.A.P. Technologies Inc. has identified stickiness as an issue and is in the process of creating an improved prototype. It is believed that if the stickiness can be reduced, the overall risk for MSI to workers has the potential to be lower than that of workers who use traps with concrete for ballast. Not only would the risk factor of forceful exertions be reduced, but so, too, might the risk factors of awkward postures (trunk and upper arms) and contact stress (hands and fingers).

Question 2:

For the task of retrieving traps with the use of hydraulics, does there appear to be any difference in MSI risk to workers in handling traps installed with R.A.P. Technologies runners versus traps with concrete for ballast? If yes, does the risk appear to be higher or lower?

Answer: For the initial step of vertically pulling traps off of the ocean floor before hydraulics is used, it is concluded that there is a reduced risk of MSI to the worker when pulling traps with R.A.P. Technologies runners compared to traps with concrete for ballast. This is due to reduced force demands on the body from a combination of reduced load weight and increased surface area for the water to flow through, which reduces friction. In regards to the horizontal pulling of traps across the aluminum deck railing, based up subjective feedback from the worker and visual observation, this part of the task appears to be more physically demanding on the worker when using traps with R.A.P. Technologies runners. As noted above, it is believed that improving the prototype such that the stickiness of the rubber is reduced will result in a reduced risk of MSI to the worker compared to using traps with concrete for ballast.

Thank you for the opportunity to complete this assessment.

Should you have any questions concerning the content of this report, please contact the undersigned at (709) 778-1124.

Sincerely,

Cherylee Osborne

MSI Prevention Advisor, Prevention Services