Project no 243452

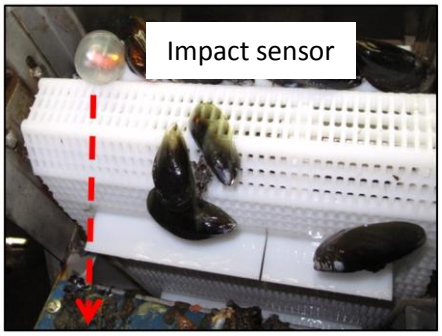
Handling best practice

Grading facilities and harvesting vessels often make use of gravity to transport mussels between machinery, e.g. drops. The number of handling steps and levels of mechanical impact should be reduced to a minimum to maintain mussel quality and increase yield.

Impact identification

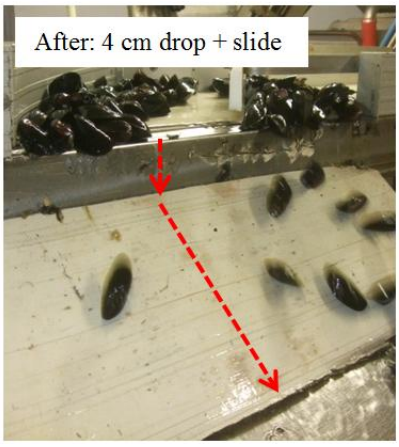
Listen: One can easily hear the loud noise of mussels hitting hard surfaces like stainless steel in grading facilities and even on harvesting vessels. The presence of loud noises is a sign of improvement potential for reducing impact from handling. One should also look for mussels hitting sharp edges, bars and straight at surfaces without sliding.

Measure: An 'e-shell' sensor is a valuable tool for identifying and quantifying critical points, and can be used as a supplement the above method. This device quantifies impact in g-forces.



Impact reduction

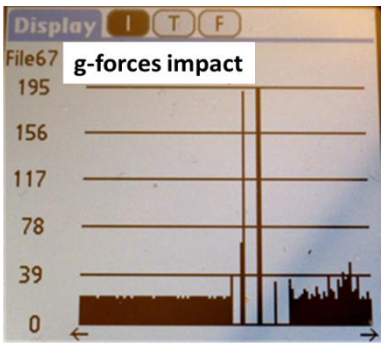
Mechanical impact can be reduced with little effort and low-cost solutions. The example below shows how impact can be reduced by replacing a drop with a slide in between a conveyor and a debysser.



Recommendations to industry

- Number of drops and drop heights should be minimised.
- The surface mussels fall on should be shock absorbing.
- Consider carefully choice of material and shape of surfaces.
- Water can be used as shock absorbing medium,
- Drops should be replaced with slides where possible.

For additional reading, see MusselsAlive reports D2.1 and D2.2.



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Mussel stripping - make your choice

Importance of making the right choice

Stripping is the manual or mechanical process of removing mussels from the lines/ropes. Most stripping systems are followed by mechanical declumping which requires that mussels are separated from rope to work properly.

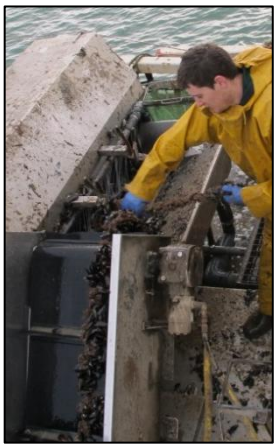
Manual stripping

Pros

- Effective for loose seed, or for large mussels during summer when byssal attachment is weaker
- Acceptable for small harvesting vessels and short periods when production volumes are low

Cons

- Harder to control workflow
- Low volume output
- Requires manual force and endurance
- Employees prone to injuries
- May cause greater breakage to mussels



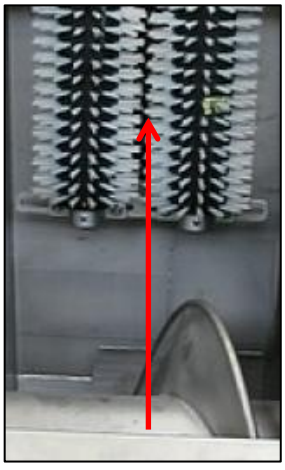
Mechanical stripping

Pros

- High volume output, efficient
- Easier to control workflow
- Cost-effective
- Employees less prone to injuries
- Breakage can be reduced with product flow control for seasonal differences in byssal attachment
- Greater production capacity facilitates increased grading potential

Cons

- Need hydraulic power
- Need more vessel space to accommodate the higher volume output
- Higher output speeds and poor adjustments can increase breakage



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Mussel breakage and its causes

Recommendations to industry

- Evaluation of the specific types of damage to the mussel shells can give clear indications of what part of the production process causes the greatest loss.
- Yield can be significantly improved if you identify the source of the damage to mussels, instead of simply removing and discarding them at the inspection table.
- Reduce breakage and increase yield by modifying or adjusting equipment.

Which impacts causes different types of breakage?

Cracked shell tip

Shell extremity is cracked and slightly crushed, but mussel is still intact and living.

Possible cause

- Static stripper with large opening.
- Declumper knives too far from barrel wall.
- May occur in a debysser with wide gaps between the knurled bars, but usually this is accompanied by a sanded down effect on shell tips.

Broken-off shell tip

One or both shell valves are broken off at the tip, leaving the meat completely exposed. The mussels die rapidly.

- Generally observed when mussels get caught or jammed between a declumper knife and the barrel wall, which should not occur if blades have very narrow mm gap.
- Also seen after mussels fall and are pushed into a spiral rubber declumper as the blade rotates and cuts the mussel in pieces.
- This clean break may also occur when the gaps along a static grading barrel are so wide that the mussel tip gets pushed in and other mussels push it sideways. This can occur for many mussel sizes

Broken/crushed shell

Mussels are nearly destroyed with large pieces of shell broken from the mussel. Tissue is exposed and mussel slowly dies of desiccation.

- Typical of mussels stripped off the ropes through static bars with very wide opening or poor guiding through the bars.
- Rapid stripping of mussels.
- Mussels piling up in declumper and forced through a smaller opening into the barrel.
- Mussels from the bottom of heavy bag drop onto a hard surface and get crushed.
- Crushing of mussels that are packed at bottom of barrel toward the end of barrel declumper where door is too closed.

Dislocated & broken shell part

The thickest part of the mussel shell near the hinge is exploded outward along a fracture line. This outward projection is likely due to the elasticity of the hinge.

- Generally observed after impact situations or from sudden compression in thicker mussel shells that can resist crushing.
- Seems to be noticeable along a fracture line between older shell and fast growth shell.
- The impact often dislocates the shells slightly.

Hole in shell:

The hole on one side of the shell valve is generally around 5-10mm in diameter and observed very typically when brush declumpers are used.

- Typical of rigid bristles from brush declumpers that are poorly adjusted.
- The mussels get punctured when the gap between two brushes are big enough to allow a mussel to be caught at the tip of a bristle.

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Debyssers - make your choice

Importance of making the right choice

Debyssing is the process of removing the byssus threads from the mussels by mechanical means. It is important for the survival and quality of the mussel to keep the foot of the mussel intact inside its body, otherwise internal damage of the live mussel will occur. Accordingly, debyssers should cut the byssus instead of dragging it or pulling it off.

'Knurled Bar' debysser – the industry standard

Pros

- Effective for removing byssus
- Less organic material such as byssus can raise the perceived quality by the consumer by reducing smell and look clean.
- Very efficient with sufficient water supply
- Debyssers come in a variety of sizes to meet volume requirements

Cons

- Requires inspection of bars regularly
  - Can cause breakage if dull or warped bars
  - Can cause partly or complete removal of the mussel's foot if not properly adjusted
- Needs to be cleaned daily
- Bearings need to be well lubricated
- Fresh water supply is required to maintain the mussel quality and to preserve the equipment, as the many bearings are not made of stainless steel
- Requires well declumped and cleaned mussel input
  - Stones and metal pieces will cause damage by reducing the sharpness of the knurled bars
  - Clumps and organic matter such as stones or tube worms will affect debyssing effect

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Declumping best practice

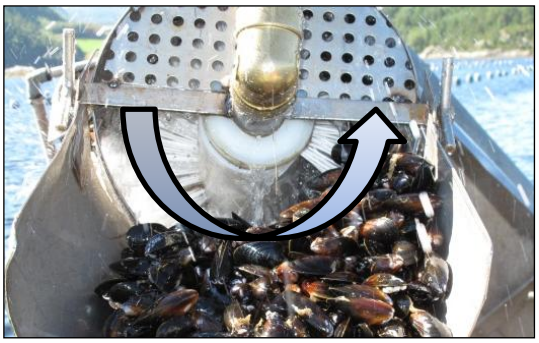
Declumping is the process of breaking the clumps apart thus separating mussels individually. Declumping is one of the critical points that induce post-harvest mechanical stress on mussels. Studies were conducted to investigate the gentleness of declumpers with regards to breakage.

Use of water

The declumping machines also wash the mussels. Lots of water should be used in the declumping process for all types of declumpers. Trials indicated that high water flow gave better washing effect and minimized breakage. Trial results showed that high water flow reduced breakage with up to 6% compared to low water flow.

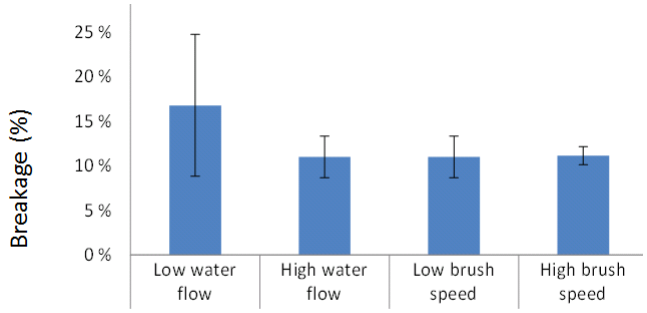
Mechanical impact on the mussels can be reduced by using large amounts of water. Along with optimized brush speed you will improve yield and product quality. Trial settings: "Spanish": 0 - 774 l/min, rotating/broom: 0 - 375 l/min.

Brush speed



Results indicated that brush rotation speed has little or no impact on breakage. Higher brush speed reduces residence time inside the machine, but causes higher abrupt impacts.

In the MusselsAlive studies, using high or low brush speed caused equal accumulated mechanical impact on the mussels. Lower speed is recommended for thin-shelled mussels, which are more sensitive to high impacts. For mussels with thicker shells, throughput can be varied according to grading demand without compromising on mussel quality. Trial settings: "Spanish": 74 - 126 RPM, rotating/broom: 6 - 16 RPM.



Breakage results from MusselsAlive trials.

Recommendations to industry

- Water flow for the 'Spanish' and rotating/broom brush declumpers should be >300 litres per minute.
- Brush speed has little impact on mussel breakage, so speed should be set based on desired throughput.
- Use lower speed for thin than thick shelled mussels.

For additional reading, see MusselsAlive reports D2.1 and D2.2.

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Declumpers - make your choice

Importance of making the right choice

Declumping is the mechanical process of separating mussels individually by tearing the mussel clumps apart. Declumping is critical to achieve efficient size grading. The process can be done at sea, at the processing/packing facility, or both.

Barrel / rotary brush declumper

Pros

- Easy to install and use
- Requires little maintenance
- Small and light-weight
- Adaptations are available:
  - Addition of extra rubber blades for declumping mussel clumps with strong byssal threads
  - Brush which has high pressure water flowing through its bristles, to gently wash the mussels

Cons

- Limited to small throughput
- The rubber blades can damage or crush thin-shelled mussels, thus reducing yield and quality
- The inlet hopper is small and does not accommodate high volume input

Brush declumpers

Pros

- Easy to install and use
- Requires little maintenance
- High throughput

Cons

- Requires relatively high water flow to reduce breakage
- Worn brushes need replacement

Broom brush declumper

Pros

- Gentle cleaning and declumping
  - Reduced damage to shells
  - Well suited for thin shelled mussels
- Great for small volumes
- Relatively compact and durable

Cons

- Not well suited for big clumps, nor where there is strong byssal attachment
- Limited throughput

Knife declumper

Pros

- Functional when well-adjusted to stock.
- Can work with all types of mussels and clumping difficulties
- High throughput

Cons

- Requires high water flow
- Hard to clean
- Dangerous if security stops are not off during cleaning or maintenance
- Poor design/materials and/or lack of maintenance results in reduced quality and yield

Broom brush declumper

Pros

- Gentle cleaning and declumping
  - Reduced damage to shells
  - Well suited for thin shelled mussels
- Great for small volumes
- Relatively compact and durable

Cons

- Not well suited for big clumps, nor where there is strong byssal attachment
- Limited throughput

Rotating cone declumper

Pros

- Relatively compact size
- Efficient at declumping mussels from plastic mesh socking
- Handles larger volumes if well equipped

Cons

- Mostly used for harvest size mussels
- Separate unit, not combined with size grading (in contrast to many other declumpers)
- Requires an abundant water flow and controlled input

Venturi pump declumper

Pros

- Cost effective for larger volumes
- Maintains mussel quality and yield

Cons

- Requires larger boat and deck space compared to other declumpers
- More costly installation to set-up/install

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Adjust size grader and increase yield

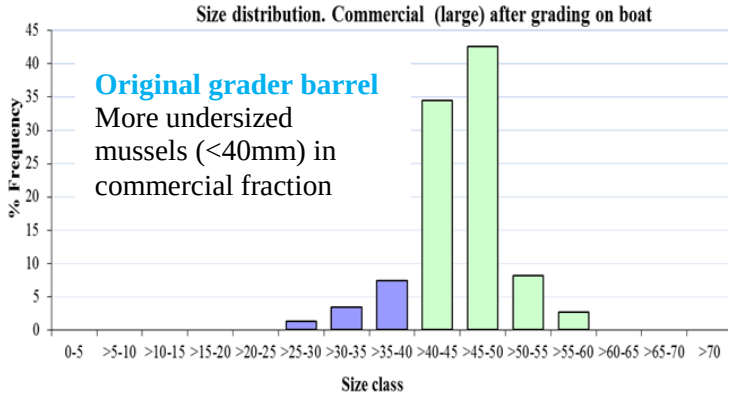
Great care should be taken in having a properly functioning size grading machine. Grading settings should be made according to the mussels' length-to-with relationship to reduce stress impact, maximize yield and minimise effort per unit time.

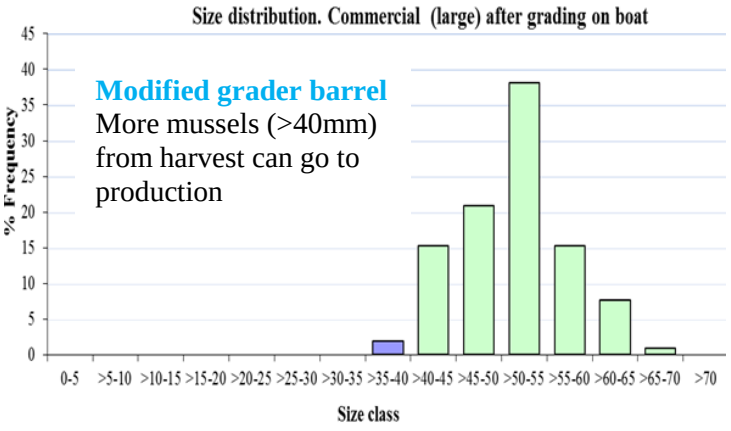
Importance of optimised size grading

The graders must have uniform gaps (space between bars) to sort mussels within desired ranges. The advantage of proper size grading is to be able to harvest even-sized mussels.

Graders separate mussels by the widest dimension (shell width). Undersized mussels will, if not sorted out early, follow the commercial sized mussels through the grading process and lower the yield for packing per unit time.

Effect of modifying grader

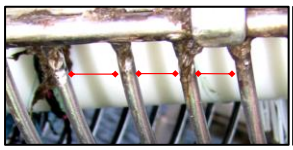




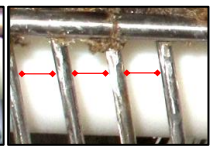
Yield definition

Yield is the amount of mussels above a given size threshold suitable for further processing or packing.

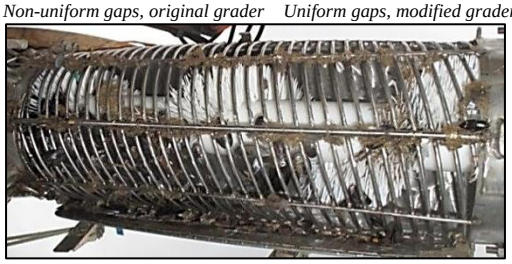
Modified grader



Non-uniform gaps, original grader



Uniform gaps, modified grader



Recommendations to industry

- Monitor grading machinery regularly
- Check size distribution after grading
- Adjust or modify graders accordingly

For additional reading, see MusselsAlive reports D2.1 and D2.2.

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Size grader adjustment best practice

Size graders must have consistent gaps to sort mussels within a desired range. Grader settings should be adjusted according to the mussels' morphology by measuring the length-with relationship of mussels from specific sites.

Mussels performance and size

Proper management requires good farm-site knowledge as well as knowing your mussels and their growth performance. Seasonal and site specific differences affect the reproduction cycle, shell growth and meat yield.

Graders separate mussels by the widest dimension, not the length, although the length is the independent parameter often referred to when discussing mussel size, or when packaging product. The width is measured at the thickest part of the two valves.

Adjustment of barrel gaps must fit the actual mussel morphology. A shell length-to-width diagram is a useful tool for making decisions for correct adjustment of your grader.

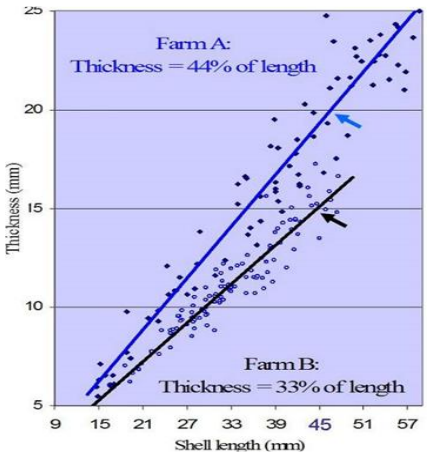
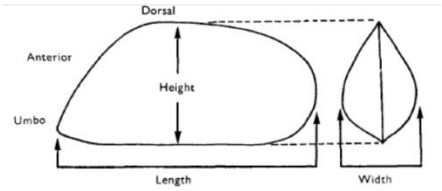


Diagram showing that mussels of same shell length may have different width (thickness).

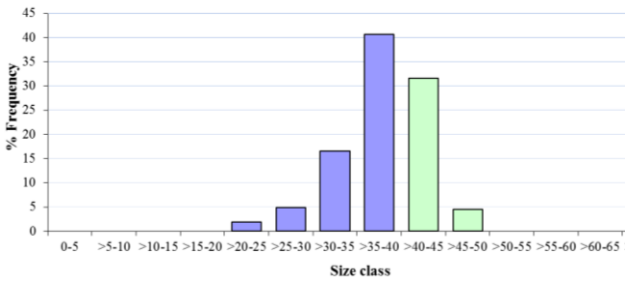
Shell morphology
Figure taken from Seed, R. 1968.



How to measure bar gaps

Measuring the bar gap width with calliper to match mussel width.

Effect on grading result



Grading result on harvesting boat where grader allowed a large fraction of commercial mussels (>40 mm length) in the undersized fraction (<40 mm length).

Recommendations to industry

- Monitor mussel growth regularly.
- Measure shell length and width of mussels from different sites before grading.
- Check the state of your grading barrels and bars yearly.
- Adjust your grader to avoid overlap of size classes in production.

For additional reading, see MusselsAlive reports D2.1 and D2.2.

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Size graders - make your choice

Importance of making the right choice

Size grading is a very important step in the processing chain, since this is where the producers have the opportunity to minimize waste and increase the yield of the mussel production at sea and in the processing plant. Size graders must be purchased and adjusted based on knowledge about the mussels that shall be processed. Size range and shell strength are important factors.

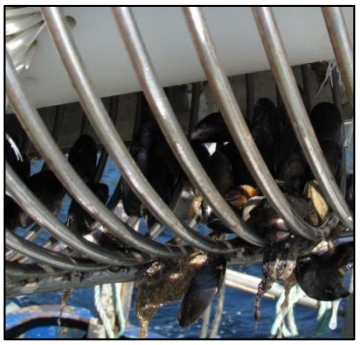
'Spanish' barrel grader (combined declumper / size grader)

Pros

- Compact and lightweight
- Easy part changes
- Easy to install and use
- The grader bar gaps are adjustable on some grades
- Can process 4 tonnes per hour with good declumping and grading of different sizes
- Requires little maintenance

Cons

- Limited to small throughput
- Input hopper does not accommodate high volumes
- Breakage may occur depending on machine design and setting, e.g. if welds are rough
- Some machines are not designed to grade many sizes, only commercial and sub-commercial
- Rings tend to loose accuracy after extended use



Fixed barrel grader

Pros

- High volume with well declumped mussels
- Little breakage with sufficient water flow
- Interchangeable grading barrels

Cons

- Not made for all mussel species and conditions
  - Works better when the commercial size mussels are large and grow fast, where sub-commercial mussels may be absent due to socking technique or fast growth

Drum barrel grader

Pros

- High throughput with well declumped mussels, taking required deck space into account.
- Works well for clumps with high byssal strength which requires rugged declumping
- Little breakage with high water flow
- Interchangeable grading sections according to the mussel sizes and categories
- Durable and seaworthy

Cons

- Not made for all mussel species and conditions
- Heavy, bulky

Vibrating table grader

Pros

- Good throughput with well declumped mussels
- Little breakage with sufficient use of water
- Compact
- Flexibility with interchangeable grading units

Cons

- Not made for all mussel species and conditions, requires well declumped mussels
- Limited to one grading level, thus no multi-size grading
- High noise level

Roller grader

Pros

- Low noise level using rotating bars (less noise than vibrating table grader)
- Fairly easy adjustment, down to millimetre accuracy
- Adjustable bars eliminate the need to change bar set
- Small risk for blocking mussels, as the big mussels and clumps passes through in the end of the unit

Cons

- More expensive system (often too expensive for small producers)
- Bars can get warped, which causes overlap in size grading
- Require a stable boat/barge
- Requires well declumped mussels

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