CLEANERFISH – BEST PRACTICE GUIDELINES FROM THE NORWEGIAN SEAFOOD RESEARCH FUND (FHF)

Industry guidelines - sea lice

Subject:	Best practice guidelines:		
Cleaner fish	**Delivery of wrasse fish**		
Prepared by:	**Contact person:**	**Date:**	23.02.2017
FHF cleaner fish project	Eirik Sigstadstø, FHF	**Page:**	**Page 1 of 62**

Objective:

To ensure that the wrasse are delivered in accordance with the order, that the fishes' welfare is attended to in the best possible manner, and that the quality criteria are adhered to.

Description	Form
1. Preparations:	
General: It is vital that the supplier receives prior notice of the recipient's requirements concerning the fish. These should be specified in the contract between recipient and supplier. The most important requirements are summarised briefly here, but described in more detail in separate guidelines for catches and transport. **Transport of wrasse by vehicle and vessel:** On entering into an agreement on the transport of wrasse the recipient should stipulate the following requirements and clarify the points listed underneath to the carrier: • Agree on a time/date, notice of arrival date of the vehicle/boat.	Example of contract between vendor and buyer

Description	Form
• Obtain advance information on where the fish are arriving from, the number of loading points and estimated time taken for loading. • Stipulate requirements for a veterinary certificate. • Stipulate requirements for the upper limit for density requested in the tanks and to maximum temperature in the transport water. • Stipulate requirements on logging of O_2, pH and temperature during the entire transport, and that this is registered and can be substantiated. Ensure that there is no significant difference in temperature between transport water and water at the delivery depot. (See transport guideline) • It is advisable to transfer all fish from a single tank on the vehicle to a single tank on the work boat. • Inform the carrier that the fish must not be transported in water with lower salinity than 25 ‰, pH shall not be less than 7.0, and should preferably lie between 7.0-7.3. • The fish shall be completely sorted with regard to species and size when they are released into the tanks, so that at the delivery depot we are able to empty tanks, without having to sort the fish. • The tanks shall be darkened and fitted with a lid and partition grating to minimise water movement and ensure the welfare of the wrasse is maintained. • Ensure that the carrier has the right equipment for unloading the fish in the manner we have requested. • Ensure that tankers have a drainage device to prevent transport tanks being filled with old water. Check that any hose couplings are correct and that hoses/pipes are long enough. • Agree beforehand on a limit for deviation; applicable to number and fish size. Fish with visible injuries/sores shall be destroyed and removed. **Delivery location :** The following must be prepared and in position on the work boat before delivery of fish from a vehicle: • Have sufficient tanks for transport of the fish and pumps for providing all tanks with fresh sea water. • Refuges in the tanks • O_2 logs • Dip net for handling of the fish • Clarify time of arrival for the vehicle	
2. Implementation:	
Delivery by vehicle: • Ensure that the driver notifies and updates on anticipated arrival time. • The delivery location must be ready and waiting with a work boat and tank or a wellboat. • Carry out delivery check and verify as detailed under subsection 3. Registration. • Upon arrival the bulk of the water is drained from the tanks on the vehicle until approximately 1 cubic metre remains. The fish are sent through a pipe over to the tanks, which should preferably stand on the workboat. If there is considerable sea pitch a tap can be utilised to regulate the pressure in the hose. • The fish are transferred to 1000-litre tanks or larger for transport out to the delivery location. Each tank must be fitted with a lid. • O_2 is logged continuously throughout the trip to the pen. The boat must have an oxygen battery and several pumps that ensure a flow of fresh seawater to all the tanks. • The fish are released into the pen by the tank being lowered into the water, or by the fish being sent through a pipe out into the pen. The fish must be kept in fresh sea water throughout the procedure. Wrasse are released directly into the refuges.	Delivery form

Description	Form
Delivery from external boat (e.g. fisher): • The fisher arrives with the fish in accordance with the agreement with the works manager. Upon arrival a representative from the delivery location shall be present to check quality, size, number and species. • The fisher shall provide a log showing O_2, temperature and catch method form. • The fish are placed gently in a refuge in the pen, either with the aid of a pipe or that the tank is lowered into the pen. Independent delivery stations placed in the salmon pen have prevented wrasse from seeking to descend to the bottom of the salmon pen, thus ensuring a far greater rate of survival. The delivery stations are fashioned in the shape of big, cylinder-formed kelp refuges or small nets with escape openings at the top. • Check with the carrier how many days the fish have been stored in transit – they should preferably be released directly into the pen. • In the interest of continual improvement, point out aspects that are good or bad. • Cleaning etc. inside the boat should be considered as an essential part of the routine (in accordance with procedures/previously defined criteria). • The contract note is written, fisher and buyer each receive a copy that is filed. A third copy shall be supplied to the Sales Association.	Delivery form
3. Registration:	
Vehicle: Upon arrival the trip log is requested for inspection, where O_2, pH and temperature shall have been registered. Delivery check: Before the fish are unloaded from the vehicle and transferred to another tank, each of the work boat's wells should be gauged by personnel from the delivery location to check O_2 and temperature. It is recommended to check temperature, O_2 and CO_2 (gauging of pH) in the water from half of the vehicle's tanks. Information from the driver is noted: number, species and size. With larger deliveries by vehicle the following is recommended: • 1 % of the fish delivery is checked for size and quality. • 20 % of the fish delivery is checked for the number of fish. Note down the number that are undersized. **Boat:** In connection with the delivery to a location, random samples are taken at regular intervals to check; species, size, number and quality. This is carried out by personnel at the delivery location. The results are registered on the delivery form, which is signed. • Each fisher shall state the number of fish caught to the works manager/person in charge. This is registered on the delivery note that is sent to the Sales Association the same day. • On enquiry it is to the advantage of the fisher if he/she can show the log/registrations over O_2 and temperature in the wells on the boat.	Delivery form Delivery form
4. Deviation management:	
All deviations shall be dealt with • All incidents and occurrences in connection with catches, storing, transport or delivery of the fish, and which may have had a negative effect on the fish/led to reduced quality of the fish, shall be registered in a deviation report. Measures already initiated to reduce the consequences of the deviation, or provisional measures to prevent the deviation from	

Description	Form
reoccurring, are also described in the report. A description is also provided of permanent (corrective) measures that have been initiated, or that are planned for implementation, to prevent similar deviations from reoccurring. The report is filed. • Previous clarification shall be agreed on actions to be taken if there are major deviations in a delivery. The fisher/supplier shall be aware of the consequences.	

Fish welfare:

- Injured fish are removed and destroyed in a compassionate way (e.g. by a blow or stupefaction).
- Use a dip net for all handling. Kelp refuge in place in transport tanks and in pen at the delivery depot.
- Most of the remaining subsection in the guideline concerns good fish welfare.

Safeguarding against escapes:

- Notification of arrival and implementation of relevant preparations before arrival of boat.
- Comply with appropriate procedures etc. at the plant site that prevent escapes during different operations, including actual risk assessments.

HSE:

- Life jacket
- Follow appropriate procedures concerning means of transport and delivery location

References:

- Guidelines for catches, transport, use and care of wrasse

Attachment: (ref: page listing wrasse guidelines on www.lusedata.no – only in Norwegian):

- Example of contract between buyer and fisher of wrasse
- Example of delivery form/quality check in Word
- Example of delivery form/quality check in Excel

Industry guidelines - sea lice

Subject:	Best practice guidelines:
Cleaner fish	**Transportation of wrasse fish**

Doc. id:		**Prepared by:**	**Contact person:**	**Date:**	05.06.2015
Version:	0.1.3	Lice project		**Page:**	**Page 5 of 62**

Objective:

To ensure that all transportation of wrasse is carried out in a manner that safeguards the health and quality of the fish.

Special conditions:

This guideline is mainly concerned with transportation by vehicle. With locally caught wrasse, transportation and catches are integral to each other. This is therefore dealt with in the catches and storage in transit guide, but the key points are also summarised in a separate section ("Transportation by vessel") in this guide.

This guideline also has a separate point dealing with “Water quality during transport” on a general basis. This is lastly addressed in point 2, “Implementation”, and has contributed to providing guidelines for several of the recommendations listed.

Description	Form
5. Preparations:	
Familiarise yourself with the current regulations: • The Regulation concerning Transportation of Aquaculture Animals: http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf, (hereafter called the Transport Regulations) which stipulates a number of requirements for welfare, equipment, the unit of transport and monitoring. **Preparations with main emphasis on vehicle transport:** • The tanks are examined to ensure that all surfaces are smooth and without sharp edges.	

Description	Form

• Refuges have been tested in vehicle tanks, but due to drawbacks with poorer water circulation and difficulties connected to disinfection, tanks without refuges are preferred.
• Experience shows that darkened tanks with covers result in less stressed wrasse, but this would most likely be the case with all transportation by vehicle. Farmed ballan wrasse need light during transport.
• Good water quality in the tanks is vital! See more specific information on O_2 and CO_2 at the end of this guideline.
 
An oxygenation system with automatic adjustment and logging must be installed. O_2 levels shall lie between 80% and 100 %. In order to maintain good oxygen levels in smaller tanks, it may nonetheless be necessary to adjust the blend up to 125 %. Levels both over and below this are unfavourable. Other levels may lead to stress reactions and eventually prompt disease and mortalities. An aeration system for ventilation of CO_2 shall be installed. CO_2 presents a greater challenge in sea water than in fresh water, and has close interaction with pH levels. Logging of pH can therefore be utilised to monitor CO_2. CO_2 should lie below 15 mg/l and a level of pH maintained over 7. High CO_2 levels can cause stress reactions, and eventually prompt disease and mortalities.
• The equipment must be in place before the season starts and personnel instructed on its use.
• The following requirements shall be clarified prior to entering into an agreement on transport:
  ○ Contact must be established between buyer, vendor and carrier.
  ○ The quantity of fish to be transported in each tank; maximum number per species.
  ○ Which documentation will be at hand, and who is responsible.
  ○ Requirements for water; aim at achieving the closest possible identical conditions from the vendor/ on transport/to the recipient for temperature and salinity. Assess intake of water at deeper levels of tanks at the vendor's premises.
  ○ Monitoring of water quality underway (O_2, pH, temp.).
  ○ A plan for loading/unloading against times for high tide/low tide, to avoid extremes in height elevation when unloading.
  ○ A plan for cleaning and disinfection of vehicle and all equipment, applies to the vendor/carrier and recipient.
  ○ The recipient must have hoses ready to be coupled to the vehicles, enough tanks/vats to receive the cleaner fish, and equipment for water replacement / oxygenation. See point *Delivery to cage from tanks on deck* on next page.
• Water and fish must be collected from an infection-free area; to be clarified between supplier and buyer cf. guideline *Catches and storage-in-transit of wrasse fish,* point: *Prevent spread of infection* with link to the Norwegian Veterinary Institute's (NVI) (constantly updated) chart over registered outbreaks of ISA (*infectious salmon anaemia)* and PD (*pancreas disease).*
• Fish that are loaded shall be fully sorted beforehand according to species and size.
• Fish that are loaded shall be starved beforehand for a minimum of 1-2 full days.
• The carrier and buyer shall know the number of each of the different species before loading starts.
• Be conversant with the regulations. See link to the Transport Regulations under "Attachment".
	Transport Regulations

6. Implementation:	
<u>Loading:</u>	

Description	Form
• The vehicle's tanks must be filled with water of good quality: Preferably all sea water, but at least with a minimum of 25 ppt (parts per thousand) of salt. Good visibility, and minimum traces of humus (biological matter, sediment). The temperature in the transport water should be a minimum of 8-9 °C and not exceed 18°C. Pronounced changes in temperature cause stress for the fish. • Only use a dip net for handling the fish when loading. Do not have too many fish in the dip net at one time. • Wrasse fish must NEVER be left dry (out of water), as this weakens them and could cause the fish to become diseased. **Transport:** • Temperature, O_2 and pH shall be logged during transportation. There should be automatic adjustment of O_2, but if absent this can also be adjusted manually, providing one has a constant overview of the level. CO_2 aerators must be employed immediately if pH sinks below 7.2 • With long-distance transportation, tank water must be able to be replaced en route (no later than after 15 -20 hours transportation time) to eliminate ammonia. See explanation of "Ammonia" provided later in this guideline. • With major differences in temperature between from where the fish are collected to where the fish are delivered, one must assess whether to replace the water en route with lower temperature water to allow the fish to acclimatise (N.B. salinity). If necessary, transportation time must be extended significantly to enable the fish to acclimatise gradually. Pronounced differences in temperature can cause considerable stress in the fish and at worst lead to disease or acute mortalities. **Unloading:** • The delivery must be clarified between the carrier and the recipient, and include a plan for unloading. • The vehicle's tanks are drained so that as much water as possible is removed before unloading. However, they must not be drained to the extent that the wrasse are left high and dry. • Supply of oxygen should remain on during drainage until unloading commences. • The fish are unloaded from the vehicle via a hose down into a well on the vessel, or into tanks on deck. • If possible, a filtering system should be used to avoid waters of differing quality being mixed in (mixing zone problem: there can be a risk of ammonia poisoning through an increase in pH after long periods of CO_2 aeration) • Ensure that wrasse do not pile up in any twists or bends in the unloading hose, at the same time take care that pressure in the hose does not build up so much that it subjects the cleaner fish to rough handling. No wrasse must be left behind in the hose when transferring fish between different tanks. • Receival units must have good water replacement systems that comply with the recommendations for transportation by vessel. See industry guideline *Catches and storage-in-transit of wrasse fish.* • The recipient must carry out an inspection of the delivery on arrival: to ascertain quality of the fish, check logging of water quality. **Delivery to cage from tanks on vessel deck:** • Planning of the transportation should focus on achieving the successful transfer of fish from one tank or tanks on a vehicle for further carriage in a tank/tanks on a vessel, to be finally released into a marine farm cage. This ensures traceability.	

Description	Form

- The number of fish in each tank must be adjusted to the type of fish, size of the tank and water capacity. In 1000-litre tanks the replacement capacity should be 200 Litres/minute. Total water replacement for the whole tank takes approximately 5 minutes. The oxygen level must not be less than 80 %.
- In order to get enough water to all the tanks, it may be necessary to have a depot vat where the vessel's flushing pump is used to action replenishment, while a number of smaller pumps distribute water from there to the tanks. This is a practical consideration that must be adapted in each instance.
- For an overview of quantity of fish in the tanks; see paragraph "Transportation by vessel".
- If the number of fish in the vehicle's tanks exceeds the recommended quantity of fish for the vessel's tanks, the fish can be distributed more evenly among the vessel's tanks with the aid of a dip net. See guideline for inspection of delivery, including counting of fish.

Delivery to cage by well boat:

- The same principles apply to a well boat as with transportation by vessel. Both a dip net and pump can be employed when unloading from vessel to cage. When pumping, an internal assessment must be carried out with regard to the welfare of the wrasse. Wrasse have low tolerance for elevated pumping, and are considerably more sensitive to differences in pressure levels than salmon.

Transportation by vessel:

- Many of the points under "Preparations" also apply to transportation by vessel.
- Have a spacious fish well with continuous circulation. Oxygenation equipment must be in place
- Recommended quantity of fish in the tanks: The most secure method to safeguard the fishes' welfare is to have control over the level of oxygen, which shall not be less than 80 %. If this cannot be measured, use the table underneath as a guideline. This shows the recommended quantity of fish for short transportation (30-60 min.) and longer transportation. (Translator remark: Cannot access table)

Grense	Små	Ant/m3 kort	Ant/m3 lang	Stor	Ant/m3 kort	Ant/m3 lang
Bergnebb	11 cm	4000	2000	-	-	-
Grønngylt	11 cm	4000	2000	15 cm	1000	500
Berggylt	12 cm	4000	2000	17 cm	500	250

- A good holding tank must consist of several compartments or have a perforated grid to keep the different cleaner fish species apart. This is also a practical solution to reduce movement in the water. However, be aware that the grids inhibit water circulation, so each compartment should have its own water supply.
- It is vital to have good oxygen conditions in the holding tank. Installation of pumps that ensure flow-through and replacement of water (200 litres / minute/m^3) continuously into each tank compartment, provide good oxygen conditions for the wrasse. Avoid pumping in sea water with very low salinity.
- O_2 levels must maintain a minimum of 80 % saturation. Oxygen should be measured and logged continuously.
  The oxygen logger must be in place before the start of the season and personnel having received instructions on its use.
- Substantial pumping capacity (back up-system).
- A livewell with a cover lowers fish stress levels. It should be dark inside the livewell.
- A refuge in the well will help to calm the fish. Use e.g. kelp clusters/artificial kelp or similar.
- Extra oxygen should be available as a supplement during transportation involving high temperatures; alternatively the quantity of fish to be transported must be calculated accurately.

Description	Form
• Fishers should be prohibited from sailing into heavy seas (stamping) with fish in the well in order to avoid causing injury to the fish, as the fish could subsequently develop sores a few days after completion of rough transportation.  **<u>Water quality during transportation:</u>** The vehicle can in some respects be regarded as a simplified variant of a recirculation plant. The principal difference is that the fish are not fed, and that they are starved prior to transportation. **Oxygen (O_2):** Oxygen levels are relatively straightforward "to have control over". With a little fine tuning of manual equipment, or automatically with a sensor, this is easy to gauge, and levels between 80 % - 125 % are easy to maintain. • The fisher/carrier must be able to document the oxygen conditions in the livewell/tank. The best practice is to continuously log oxygen levels, but oxygen should, at a minimum, be gauged every 5th minute. Suggested rule of thumb; oxygen levels should never drop below 80 % saturation. • The fishes' oxygen requirements increase with changes in sea temperature. In the meantime the amount of oxygen in the sea sinks with high temperatures. It is vital to take this into account. • Sea temperatures are highest and oxygen levels lowest in the period July - October. This coincides with the best period for catching wrasse. This means considerably fewer wrasse (lower density) can be transported than is possible earlier in the season. • Wrasse get easily stressed during transportation and handling, which can cause oxygen content in the fish tank to drop significantly. It has been observed that by merely removing the cover of the fish tank, and in a split second, the level of oxygen in the water has lowered drastically. • An oxygen meter is calibrated in accordance with the manual's instructions and is documented for the information of the supplier and recipient. **Carbon dioxide (CO_2):** CO_2 is more challenging. Fresh water is very different from salt water. Tanker carrier transportation with fish in fresh water (e.g. salmon) has as a rule functioned adequately without CO_2 aeration. Salt water, on the other hand, contains an abundance of ions (first-rate electrical conductors), meanwhile CO_2 is a polar charged molecule. These molecules dissolve readily in the ion-rich salt water. Meanwhile, CO_2 is extremely difficult to eliminate from salt water. A good aerator can nonetheless remove a certain amount; enough to "keep it in check". When CO_2 in salt water increases, pH is reduced. Measuring of pH can therefore be used as a reliable method of measuring CO_2. Rule of thumb: pH shall be greater than 7.0. This ensures the level of carbon dioxide remains well below 15 mg CO_2/litre sea water. **Ammonia:** In very simple terms; a fish that consumes food excretes a lot of ammonia, while a fish that has been starved excretes very little. Therefore the problem is significantly reduced if the fish is	

Description	Form
starved before transportation. Ammonia (toxic) is in balance with ammonium (non-toxic) in the water, but if the pH level rises, so does the percentage of ammonia. Therefore one must use caution with raising the level of pH. Very little toxic ammonia will remain if a level of pH 7.0 - 7.3 is maintained. A good compromise is to have the aerators working so that pH remains just over 7.0. This facilitates satisfactory levels of CO_2, and low levels of ammonia, providing the best possible conditions for the fish. **A tanker driver must pay attention to the following:** • Oxygen dosage - (80 % - 125 % saturation). Can be wholly automated. • Have CO_2 aerators installed and take measurements of pH in the tanks, pH between 7.0 – 7.3 is the ideal level. • The temperature should remain the same (as near as possible) throughout the journey from the sender to the recipient, minimum 8-9°C, max 18°C	
7. Registration of:	
• Temperature and water quality (O_2 and pH) under transportation by vehicle. • Oxygen levels during transportation by vessel. • Other documentation that has been agreed upon between buyer, vendor and carrier.	Example of delivery form /quality check
8. Deviation management:	
All deviations shall be dealt with: • All incidents and occurrences in connection with loading/transportation or delivery of the fish, and which may have had a negative effect on the fish/led to reduced quality of the fish, shall be registered in a deviation report. Measures already initiated to reduce the consequences of the deviation, or provisional measures to prevent the deviation from reoccurring, are also described in the report. A description is also provided of permanent (corrective) measures that have been initiated, or that are planned for implementation, to prevent similar deviations from reoccurring. The report is filed.	

Fish welfare:

Many of the guideline's points are about fish welfare, and the recommendations given are mainly concerned with making certain the cleaner fish are well cared for, thus ensuring first-class quality fish. This is also decisive to the cleaner fishes' ability to function as intended at the marine farm.

Safeguarding against escapes:

- Correct minimum size of the fish.
- Sensible safety precautions and supervision with loading and unloading.
- Notify the marine farm and agree time/date for delivery of the cleaner fish. Follow the marine farm's directions.

HSE:

- Life jacket and safety harness
- NB! Remember safety precautions in connection with use of oxygen. Agree on time/date so that the installation/facility can prepare for delivery of the fish.

References:

- The Transport Regulations (link to current issue: http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdfhttp://www.lovdata.no/cgi-wift/ldles?doc=/sf/sf/sf-20080617-0820.html)
- Diverse regulations, advice and guidelines Norwegian Directorate of Fisheries (http://www.fiskeridir.no/) or the Norwegian Food Safety Authority (http://www.mattilsynet.no/)
- Various sections of the quality assurance system pertinent to enterprises represented in Leppefiskgruppa in Mid-Norway

Attachments:

- Example of delivery form/quality check in Word
- Example of delivery form/quality check in Excel

Industry guidelines – sea lice

Subject:	Best practice guidelines:
Cleaner fish	**Overwintering of wrasse**

Prepared by:	Contact person:	Date:	01.12.16
FHF cleaner fish project	Eirik Sigstadstø, FHF	Page:	**Page 12 of 62**

Objective:

To help provide the best possible welfare for wrasse during winter. This guideline is mainly focused on the wrasse, whose needs in winter differ from those of the lumpfish. During this time lumpfish are probably more active than wrasse, but wrasse need extra attention through winter to be able to function as effective consumers of lice the following season.

Special conditions

In 2016 fishing for cleaner wrasse in Norway was quota-regulated and the season's start was set by the authorities for summer (early July for Southern Norway and Western Norway, late July for Trøndelag). This means supplies of new, wild wrasse are not available in spring, thus highlighting the need to give wrasse livestock proper care during winter.

Description

Preparations:

Familiarise yourself with the current regulations:
There are no specific regulations on cleaner fish. Cleaner fish are legally considered aquaculture animals from the time they are captured. The Norwegian Food Safety Authority regulates farming, welfare and use of cleaner fish according to the same regulations that apply to the care of fish farmed for human consumption.

Norwegian Food Safety Authority (NFSA); on cleaner fish with reference to current acts and regulations:
http://www.mattilsynet.no/fisk_og_akvakultur/akvakultur/rensefisk/
(N.B.: On the NFSA website, click on Language for English)

General information about wrasse in winter:
It is not known for certain where wild wrasse are located in winter, but it is assumed they seek deeper water and adopt a dormant state.

Description

When temperatures are low in fish farm pens we see that wrasse rest calmly in the refuges, but it has also been observed that they can be active through winter and require feeding. Keep an eye on behaviour as this can vary from species to species. If the wrasse adopts a dormant state it will not tolerate sudden variations in depth/temperature/water quality.

Refuges:

Stable conditions are best achieved by letting the refuges remain totally undisturbed in the farm pen all winter long. If the refuges are to be left undisturbed throughout the winter, thus providing the wrasse with a calm environment, the refuges must be spotlessly clean and in good condition when they are set out/washed the last time.

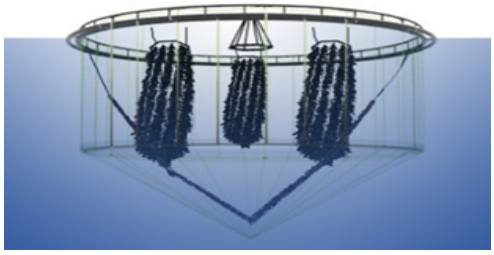
It is vital to have sufficient refuges in winter so that cleaner fish can seek out a preferred calm spot with best possible stable water quality. With the aid of a camera observe the place(s) most frequented by the wrasse. If only part of the refuge is preferred then more refuges are needed rather than aim to have the cleaner fish distributed evenly from top to bottom of the refuge.

Some producers have been successful with overwintering by sinking the refuges lower down in the pen through winter and leaving the wrasse to settle in a trance-like state in the deeper water, while other producers have registered their wrasse are also active in wintertime.

Refuges are designed to function as de-lousing stations, i.e. a place the salmon seek out in order to be de-loused. Several types of ring refuge and refuge curtain are available on the market.

Many recommend refuge curtains as they provide ample opportunity for the salmon to come into contact with cleaner fish. The refuge curtains are hung out in parallel lines (see illustration) where experience shows that a distance of 2-4 metres between each curtain and 1-1.5m between each kelp ribbon provides a spacious area where the salmon and cleaner fish can meet. The distance between the kelp ribbons must be assessed in terms of how many metres of refuge are required and how many refuges are to be utilised in the pen. Users have reported conditions are improved by increasing the number of kelp ribbons and reducing the distance between the kelp ribbons as one alternative to adding more refuges.

Description



If faced with the challenge of cleaner fish seeking cover in the dead fish system, the fish can be steered away from there by attaching a kelp 'climbing rope' (leader refuge) from the dead fish system up to the refuges. This is done by attaching a weight on the middle of a long kelp ribbon and sinking this down to the dead fish system. Some producers have however reported a drawback with the leader refuge as the Goldsinny wrasse (Ctenolabrus rupestris) in particular, has been known to use this as a route to reach the dead fish system. One alternative to the leader refuge is to hang a refuge sphere over the dead fish system, so that any wrasse move into the refuge sphere instead when dead fish are being hauled up from the pen.

Plan ahead for net changes:

Ensure overwintering cleaner fish are not lost when switching nets! Any net change must be postponed until new cleaner fish have been obtained.
If the net must be changed during winter it is better to do this instead in the autumn, and release 13cm+ wrasse into the changed net for overwintering. See attachment on sizes for nets and fish.

Feeding

Producers are encouraged to feed wrasse throughout winter also, as wrasse have been observed in activity at low temperatures. Wrasse can be fussy about food but formulated feed is available on the market for both lumpfish and wrasse. It is recommended to have several feeding stations down in the refuges. One way of observing activity and monitoring appetite is by attaching some bait bags close to the pen rim, as otherwise it can prove quite a challenge monitoring appetite and responses of wrasse that are 'hidden' in refuges.

9. Implementation:	
Refuges The refuges are installed slightly below the worst fouling zone, approximately 2-3 m below the surface so that they remain as still as possible in the salmon pens, and are stable and neutral in terms of weight. The most important consideration is to make sure the refuges remain undisturbed at the chosen depth. The refuges are equipped with weights or lead weighted rope to provide stability and sinking capability. Make sure the refuges cannot rub abrasively on the net. Follow the user manual for installation of refuges. Attach a rope from the weight to the surface so that it is easier to lift when covering the pen with a canopy. The refuges must remain undisturbed throughout the winter, and not be replaced until the wrasse show signs of activity and are capable of moving to a new refuge. Reduced cleaning of refuges during winter must	

Description	
be evaluated against the lumpfishes' requirements for clean refuges if both fish species are employed in the same pen. **Aligning and replacement of refuge** When lining up net walls, refuges should be placed parallel with the net wall. When flush hosing net walls, make sure the refuges are adequately distanced from the hosing area so that water quality is not affected. Use the camera actively, and ask divers/workers hosing to make observations. Use their observations to improve routines. When changing a refuge for the first time after winter: Set in new refuge beside the old refuge. Slowly and carefully lift the old refuge up from the sea. Preferably lift in stages with short intervals between each lift. **Feeding recommendations** Previously it has been recommended that supplementary feeding is unnecessary for wrasse if temperatures drop below 6˚C. Wrasse have however been observed in activity through winters with low temperatures and thus will need food. Observe wrasse activity and adjust feeding if it should become dormant. General recommendations for Skretting and Biomar wrasse feed: With wrasse feeds from Skretting (Clean Soft 12) and Biomar (Symbio Maintenance 12) it is recommended that fish are fed from a submerged feeding unit. The feed is laid in a soft bait bag or a flexible nylon stocking (see photo). The bag must be made of soft material to prevent injury to fish noses. The bait bag/stocking is then placed in the refuge, preferably at several feeding points at various depths. Bait bags/stockings should generally be refilled 3 times a week, less frequently when temperatures are below 6-7 ˚C. The need for refills can vary depending on appetite and number of bait bags in the pen. Other producers' recommendations on feeding: Wrasse take a long time to become accustomed to feeding in this manner. Wrasse are fed the equivalent of 0.7 – 1 % of the wrasse biomass weight daily at the preferred habitation points (in refuges/cleaner fish stations).	

Description	
 Also see: http://www.skretting.com/nb-NO/arter/leppefisk/foranbefaling/ (only in Norwegian) http://www.biomar.com/Countries/Norway/Product/Symbio_230x297_korrigert%20PDF%2022%20feb.PDF Assess how overwintering has been for the current year and make a plan for winter next year!	
10. Registration of:	
Identical to the guideline for Use and husbandry of wrasse fish: • Release(s) of wrasse: Supplier, date, species, size, number, catch area. • Dead fish: Number and species, any cause of mortality. • Species blend percentage. • Termination of wrasse usage.	
11. Deviation management	
• Normal deviation management applies if deviations should occur.	

Fish welfare:

Many of the guideline's points are about fish welfare, and the recommendations given are mainly concerned with making certain the cleaner fish are well cared for, thus ensuring first-class quality fish. This is also decisive to the cleaner fishes' ability to function as intended at the marine farm.

Safeguarding against escapes:

- Good routines for delivery of cleaner fish
- Safeguard according to minimum size and ensure the net has the correct mesh width
- Use refuges that are resistant to rubbing abrasively against the net. Refuges are considered extra equipment to be utilised as recommended in the user manual.

- Good routines for release and lifting/replacement of refuges

HSE:

- Life jacket
- Other procedures that apply to the farm site/facility

References:

- The Aquaculture Operation Regulations (translation): http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf
- The Norwegian Animal Welfare Act (*Dyrevelferdsloven*) (translation): https://www.regjeringen.no/en/dokumenter/animal-welfare-act/id571188/
- Fishing for wrasse is regulated by the Norwegian Directorate of Fisheries, and the regulations have been uploaded to the Directorate's website.
- http://www.fiskeridir.no/Yrkesfiske/Tema/Leppefisk (only in Norwegian)

Attachments:

Net sizes and ideal sizes for wrasse and lumpfish.
Prepared by Marine Harvest Midt.

Scope	Half mesh	Full mesh	Goldsinny	Corkwing	Farmed Ballan	Farmed BG	Lumpfish (width /height)	Lumpfish
40	15.5 mm	27.5 mm	11 cm		11 cm	38 gram	21.9mm/17.5 mm	6.2 gram
38	16.5 mm	33 mm	12 cm		11.5 cm	38 gram	23.3 mm/18.6 mm	7 gram
35	18 mm	36 mm	13 cm	12 cm*	14 cm	60 gram	25.5 mm/20.2 mm	8.2 gram
32	20 mm	35 mm	13.5 cm	13 cm	15 cm		27.6 mm/21.7 mm	9.4 gram
30	21 mm	38 mm		15 cm	16 cm		29.7 mm/22.8 mm	13 gram
28	22.5 mm	40 mm		15 cm	17 cm		31.1 mm/23.3 mm	15 gram
25	25.5 mm	42 mm		17 cm	19 cm		34.5 mm/24.9 mm	24 gram
22	29 mm	50 mm		18 cm	20 cm		41 mm/27 mm	

*Minimum size

Industry guidelines – sea lice

Subject:	Best practice guidelines:
Cleaner fish	**Use and husbandry of wrasse fish**

Prepared by:	Contact person:	Date:	17.02.17
FHF Cleaner fish project	Randi N Grøntvedt, INAQ AS	Page:	**Page 18 of 62**

Objective:

To achieve optimum, effective and sustainable use of wrasse to combat lice in marine farming.

	Form
12. Preparations:	

General:

The employment of wrasse in a marine farming operation must be planned well in advance. The enterprise must be registered as the buyer; contracts with fishers must be signed and sealed and motivation and training must be provided for the facility/installation's employees. Familiarise yourself with current regulations. Cleaner fish are legally considered aquaculture animals from the time they are captured. The Norwegian Food Safety Authority regulates farming, welfare and use of cleaner fish according to the same regulations that apply to the care of fish farmed for human consumption. See references on last page of this guideline.
Acquire comprehensive knowledge about catches storage-in-transit, delivery, and transportation of cleaner fish by actively using the relevant industry guidelines for these areas. Necessary equipment must be in place and adapted accordingly to accommodate use of wrasse.

Net and mesh width:

Make sure the mesh width is the correct width in relation to the size of the wrasse. This varies between the species due to the differences in shape and size. If a wrasse finds a single mesh that is large enough or a gap in the mesh, it will escape!

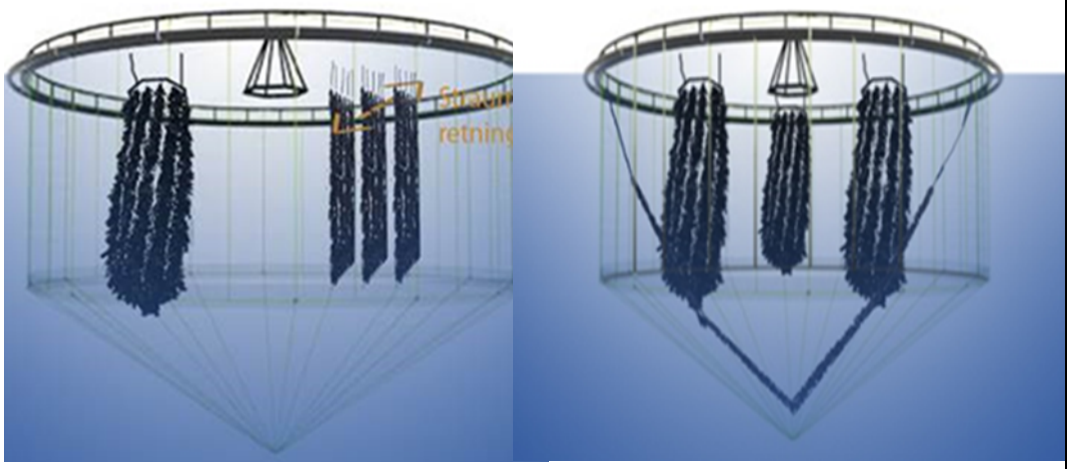
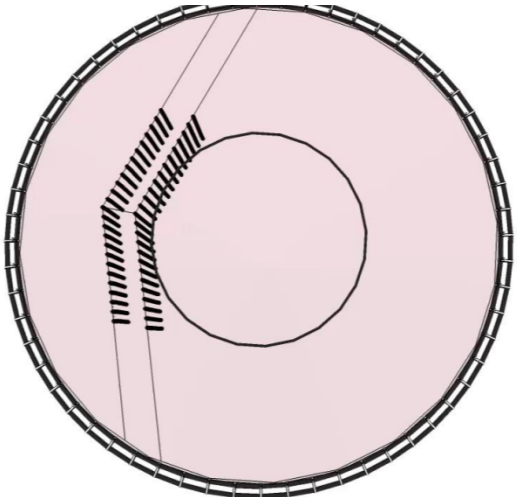
Net size and suitable size of wrasse:

On[1]	Half mesh	Whole mesh	Goldsinny	Corkwing	Farmed Ballan wrasse	Farmed BG
40	15,5 mm	27,5 mm	11 cm		11 cm	38 gram
38	16,5 mm	33 mm	12 cm		11,5 cm	38 gram
35	18 mm	36 mm	13 cm	12 cm*	14 cm	60 gram
32	20 mm	35 mm	13.5 cm	13 cm	15 cm	
30	21 mm	38 mm		15 cm	16 cm	
28	22.5 mm	40 mm		15 cm	17 cm	
25	25.5 mm	42 mm		17 cm	19 cm	
22	29 mm	50 mm		18 cm	20 cm	

*minimum size

[1] On – Norwegian mesh calculation: half the number of meshes per Alen (1 Alen = 628 mm)

	Form
Table updated by Marine Harvest Midt. A generation net, i.e. a net made of linen netting with small mesh openings may be utilised throughout the entire production cycle. However, take note that the mesh of a generation net may be too large to keep in the smallest goldsinny. Using a smolt net with subsequent net changes, will safeguard the smallest of the wrasse, in particular small goldsinny that are used as louse eaters on spring fish, and change to a net with larger mesh width when sea temperatures are lower. <u>Refuges:</u> Plan for refuges to function as cleaning stations; a place where the salmon go to be relieved of lice. Several types of refuge are available on the market, including ring refuges, garland refuges and curtain refuges. Curtain refuges are often used as these offer the salmon plenty of opportunity to come into contact with the cleaner fish. The refuge curtains are hung out in parallel lines (see illustration) where experience shows that a distance of 2-4 metres between each curtain and 1-1.5m between each kelp ribbon provides a spacious area where the salmon and cleaner fish can meet. The distance between the kelp ribbons must be evaluated in terms of how many metres of refuge one requires and how many refuges are to be utilised in the cage. Producers have reported conditions were improved by increasing the number of kelp ribbons and reducing the distance between the kelp ribbons as one alternative to adding more refuges. Refuges must be in position in the pen before the wrasse are released there. Ideally refuges should be placed so that the tops of the refuges are 2-3 metres below the surface in order to avoid the worst fouling zone. They are also located vertically in the water column to allow the wrasse the freedom to find a suitable depth according to seasonal changes in the seawater environment. Make sure there are enough weights at the bottom of the refuge to prevent the current from raising the refuge from its position. Place refuges at some distance from the net wall; to avoid having to move these before net cleaning. Plan for use of delivery refuges with releases of wrasse, as these can act as a link to refuges placed further out in the pen. Use of delivery pens can play a crucial role in acclimatising the wrasse to a new environment. This may contribute to reducing stress and facilitate wrasse establishing themselves in refuges. If faced with the challenge of cleaner fish seeking cover in the dead fish system, you can steer them away from there by attaching a kelp ‘climbing rope’ (leader refuge) from the dead fish system up to the refuges. This is done by attaching a weight on the middle of a long kelp ribbon and sinking this down to the dead fish system. Some producers have however reported a drawback with the leader refuge in that Goldsinny wrasse (Ctenolabrus rupestris) in particular, use this as a way to reach the dead fish system. One alternative to the leader refuge is to hang a refuge sphere over the dead fish system, so that any wrasse move into the refuge sphere when dead fish are being hauled up from the cage. See “Wrasse husbandry” for more information on dead fish dip nets. Bear in mind it is vital that the refuges are handled securely and efficiently in connection with different operations/incidents that may occur in the pens (e.g. escapes, HSE).	

	Form
 First illustration: Sketch of ring refuge and curtain refuge. Note the placement of the curtain refuge in relation to the direction of the current (see arrows). Second illustration: Sketch of leader refuge in a "V" form down toward the dead fish system.  Organisation of curtain refuge in corridor, an example of how refuges can be positioned to secure enough space for cleaner fish and good cleaning stations where cleaner fish and salmon meet. Illustration: Lerøy Seafood. <u>Contract between buyer and fishers:</u> Enter into contracts for all purchases of wrasse. Important points to include in the contract: • Amount, species, price, period of time. • Requirement for registration of catch journal, see guideline for *Catches and transit-in-storage.* • Requires selective devices in catch equipment to prevent unnecessary catches of undersized fish. A grating at the entrance of the net tunnel inside prevents predators from entering the catch equipment. Thickly meshed net/crossed bars in opening/net tunnel prevent large fish/otters and crabs from gaining entry and eating or injuring the wrasse. • Quality criteria pertaining to minimum size, spawning fish, health status, requirements for oxygen log etc. • Requirements for transportation and any storage-in-transit (see separate guidelines). • Routines for cleaning and disinfection.	*See cleaner fish guidelines on www.lusedata.no for:* E.g. contract between buyer and fisher of wrasse Guideline on Catches and transit-in-storage/transport /delivery Overview of the different species (wall chart)

	Form
• Requirements for shipping lanes. See guideline for "Catches and storage-in-transit of wrasse fish" to avoid spread of infection. Register the enterprise as the buyer with the local sales association, and familiarise yourself and understand the rules for sales and reporting. Training and preparation of personnel: The success of wrasse husbandry is dependent on the installation's workers. It is the responsibility of the management to ensure the workers have the necessary training and follow-up. The fish producers must follow up demands they make on the fisher(s) and ensure the fish receive the best care so that the wrasse function effectively in the salmon pen. *With use of wrasse it is vital to prepare in advance so that the wrasse are handled as gently as possible. Ensure that the fish are never left 'high and dry' out of the water.* See Norwegian Institute of Marine Research (NIMR) website for general information on the wrasse. http://www.imr.no/temasider/fisk/wrasse/nb-no (Norwegian only) <u>Blending and strategic use of wrasse</u> Take into consideration that wrasse catches are quota regulated and that this limits access to wrasse from the beginning of the season in July until around 1-2 months later. Planning is needed to decide which types of wrasse are to be used at the various installations, whose stock release times differ from each other. See table for mesh width vs. wrasse size. Example: • 1st year spring fish: Goldsinny, optionally together with small corkwing and ballan wrasse. • 1st year autumn fish: Goldsinny, optionally together with small ballan wrasse. NB: Corkwing become inactive around 7 °C. Access to wild caught wrasse for autumn fish can prove a challenge as catches are regulated. • 2nd year spring fish: Corkwing and/or ballan wrasse if available, if the salmon have not been harvested. • 2nd year autumn fish: Ballan wrasse. Corkwing can function until late autumn, but function poorly in low temperatures, and become inactive around 7 °C. Experience shows that corkwing that have not been caught locally have little effect. Cuckoo wrasse (male), cuckoo wrasse (female) and rock cook are employed to a lesser degree, but are not referred to. A number of producers report success with using farmed lumpfish as cleaner fish. For lumpfish, see separate guidelines for lumpfish. The blend percentage varies. Some use a 4-5 % blend of small wrasse, and 3-5 % blend of large wrasse, depending on which species are in use. It is possible to have a lower blend percentage when using large ballan wrasse, as these fish are very efficient (in consuming lice). Several producers have achieved success by just 1 % blending of ballan wrasse. Pens at the same installation may have different blends, depending on sea currents and level of risk for infection. Use figures from previous releases as the basis to calculate a reasonable distribution of wrasse in the different pens. • Fill each individual pen up with a mix of cleaner fish to achieve the best good effect on the pen, and to avoid intensifying the risk of infection from the individual pen. If the percentage of wrasse is small in relation to other cleaner fish, it is recommended to distribute the wrasse to individual pens as needed, and supplement as required.	

	Form
• With locally caught wrasse the fishers should deliver to own (local) delivery stations. In this way quality can be checked on the spot and feedback given directly to the fisher. • Refilling: Wrasse catch quotas restrict the potential catch for fishers in the season, which lasts 1-2 months from July. Consequently this means that the wrasse must be well cared for, and used strategically, as there is little or no possibility of restocking wrasse in autumn. Plan a wrasse strategy that allows for realistic opportunities to obtain wrasse.	
13. Delivery of wrasse:	
See separate guideline	
14. Implementation:	
<u>Wrasse husbandry:</u> • Cleaning of nets, refuges and other equipment is decisive for successful wrasse husbandry. Plan and carry out routine cleaning of all equipment that is subject to fouling. If cleaning is sub-standard, the wrasse will prefer to eat the slimy fouling instead of lice. Just a few spots of fouled buildup can make all the difference adversely; also on the dead fish dip net, feeding system or ropes. o Nets and refuges should be washed at intervals of maximum 7 – 14 days in the worst periods for fouling. o With use of wrasse over winter the refuges must be cleaned before temperatures go below 6-8 °C. If you notice the wrasse are less active, you should let them stay quietly in the refuges. Some producers observe the opposite with winter feeding, that the wrasse are active also with lower temperatures, and refuges should therefore be kept clean. o The refuges can be cleaned by drying, flushing, or by use of VHA chemicals (AkvaDes or similar) in a bath. There are also other cleaners for refuges on the market. Make sure you have an extra set of refuges that are set up in the pen before taking the old set out for cleaning. • Use of a dead fish net can pose a problem in regard to fish welfare. Wrasse often congregate in the dip net, and risk bursting when the net is pulled up to the surface. This is due (in contrast to the salmon) to the fact that wrasse have a closed swim bladder that equalises pressure through a gas gland, which takes a long time. With rapid upward movement from the depths this escapes via the fish's anus, and if the pressure is too great the fish bursts. Examples of preventive measures: o Check via the camera if it is necessary to use a dead fish dip net. o Avoid taking out dead fish the day after a large delivery of cleaner fish. o Pull up the dip net slowly; maximum 20 cm/sec. o Jerk the rope to scare off the fish. o Place refuges so they reach all the way down to the dead fish dip net to lead wrasse away from the net. Use the camera to monitor movement. o Ensure there are escape openings in the dead fish dip net. o Pull the dead fish dip net up slowly all the way to the surface, so wrasse are able to swim out. If a stop occurs underway there is a risk that dead fish will float out from the net. o Openings under the dead fish dip net may lead to escapes. These must be checked and repaired. • When registering dead wrasse; be aware that not all dead wrasse may have necessarily ended up in the dead fish dip net. • As a rule, some live wrasse turn up in the dead fish dip net. It is vital to retrieve the live fish while still in the sea, to avoid unnecessary and possibly harmful handling in the boat. With	

	Form
handling, the wrasse quickly loses some of its scales, and is thus weakened. Therefore use a small dip net to take away live wrasse before you net dead/injured fish. • The lift-up system functions well if the problem can be avoided of wrasse accumulating in the funnel/pipe. The wrasse are more easily able to make their way to a refuge if the China plastic kelp refuge reaches all the way down to the bottom of the salmon pen, or if a refuge sphere is hung over the equipment in such a way that the wrasse are naturally attracted here. Suppliers of diverse equipment systems may offer other useful advice. • Wrasse that are injured or have been left dry, must as with salmon be slaughtered before destruction and converting to ensilage; preferably in a tank with an overdose of anaesthetics or blow to the head. Even though these (dry) wrasse may look healthy, they are most likely injured, and may contract a disease and spread infection. • Where anaesthetising of wrasse is required it can prove advantageous to use a stronger dose than that applied to salmon; up to a double dose. • The salmon is a natural predator of wrasse. As salmon grow, we see now and then that they eat the wrasse in the pens. Measures: ○ Feed the salmon before releasing the wrasse (the wrasse are particularly vulnerable immediately after release into the pen(s). ○ Having sufficient refuges can prevent the problem. <u>Feeding wrasse:</u> Wrasse must be fed, and it is recommended that feeding stations are provided in the refuges. <u>General recommendations for Skretting and Biomar wrasse feed:</u> With wrasse feeds from Skretting (Clean Soft 12) and Biomar (Symbio Maintenance 12) it is recommended that fish are fed from a submerged feeding unit. The feed is laid in a soft bait bag or a flexible nylon stocking (see photo). The bag must be made of soft material to prevent injury to fish noses. The bait bag/stocking is then placed in the refuge, preferably at several feeding points at various depths. Bait bags/stockings should generally be refilled 3 times a week, less frequently when temperatures are below 6-7 ˚C. The need for refills can vary depending on appetite and number of bait bags in the cage. Other producers' recommendations on feeding: Wrasse take a long time to become accustomed to feeding in this manner. Wrasse are fed the equivalent of 0.7 – 1 % of the wrasse biomass weight daily at the preferred habitation points (in refuges/cleaner fish stations).  See also: http://www.skretting.com/nb-NO/arter/wrasse/foranbefaling/	

	Form
http://www.biomar.com/Countries/Norway/Product/Symbio_230x297_korrigert%20PDF%2022%20feb.PDF Assessing the effect the wrasse has on salmon livestock: • The effect observed is that there are some lice in motion, while a number of adult lice do not develop as would normally be anticipated (due to being eaten by the wrasse). Make sure lice levels are well monitored with frequent, thorough lice counts in all pens, so that any other measures against lice or timely refilling of wrasse can be carried out to maintain control of the lice. • The effect small wrasse have on a spring release can last up to November – January, depending on lice numbers and fish size, and right up to spring with autumn release. If the wrasse have survived overwintering they will have a good effect during the otherwise difficult spring months. • The effect from large wrasse varies; here it is more complicated. Perform an autopsy on wrasse to look for lice in its stomach; stroke stomach content into a small receptacle with water. Use a white background, as it is then easier to distinguish what is there. Stomach content breaks down rapidly. It is therefore vital to check wrasse immediately after an active grazing period, ideally midday 1 hour after the salmon have been fed. The camera is a good aid for observing when the wrasse are grazing. **Welfare/Health checks:** The wrasse are required to undergo health checks. Checks are normally at the same time as standard health checks at the facility/installation, where the veterinary inspector examines both cleaner fish and salmon once monthly. • The fish health service must be contacted in the event of high mortalities occurring. • Dead fish must be retrieved daily. Mortalities are registered by number (of dead fish) and species. This is a way to determine the blend percentage and make any appropriate adjustments. Mortalities are reported to the Norwegian Food Safety Authority. Cause(s) of death(s) should also be noted in a diary or journal system. In order to avoid the spread of infection, the sick or dead fish must be dealt with according to the same methods as applied to the salmon (slaughter/conversion to ensilage). ○ The most common causes for mortalities are injuries (that occur especially immediately before and after spawning), fish that have burst in the dead fish dip net or are retrieved due to having large, deep nose injuries caused by staying too long in the storage container or creel, and bacterial diseases that are often triggered by rough treatment, stress or injuries. • Wrasse nipping at the eyes of salmon can occur, but has not proved to be a significant problem. • Many have observed that salmonids, rainbow trout in particular, eat wrasse. There is some uncertainty here about whether the wrasse that are eaten are healthy and quick swimmers, or this largely occurs to fish with impaired health. As mentioned initially, this can be prevented by carrying out catches and transportation in a sensitive manner, see separate guideline, and prevented at the farm installation by feeding the salmon just before the lumpfish are released into the pen, and ensuring a sufficient number of refuges and that these are positioned correctly in relation to sea currents, quantity, depth etc. **Handling of wrasse before/during delousing** Pay attention to the wrasse during delousing. The primary concern should be to keep the wrasse away from delousing equipment that is engaged in crowding, pumping and handling of fish. Some producers move refuges to the opposite end of the pen from where the delousing equipment is located. Most of the wrasse stay in the refuges, away from cast nets and weighted dragnets have passed under the refuges. Nonetheless, watch out for wrasse that have become	

	Form
entangled in the cast net and end up in the well boat/delousing equipment. These must be retrieved and handled as gently as possible. Check equipment that is adapted to take care of cleaner fish during delousing operations functions correctly.  Photograph of pen during delousing procedure, where refuges are moved to opposite side of where the well boat is anchored. Large numbers of wrasse observed in the refuges, thus avoiding handling and pumping due to delousing. **Termination (sorting, relocating, slaughtering or other situations):** • Retrieval of fish may be necessary if the wrasse cannot be used any longer in the same pen/installation, e.g. prior to a pen change, sorting, delousing, or laying fallow. • Further use of wrasse at another facility/installation is permitted, but consideration must be given to the risk of infection transfer after any quarantine period. Wrasse cannot be moved in or out of areas with restrictions. Moving must be risk-assessed by the individual enterprise and normal regulations for moving of fish also apply to wrasse. If the installation has pens available that can use the wrasse afterwards, a transfer to these can be made after the wrasse have been retrieved. Use retrieval equipment that is suited to the species. • Sorting: Wrasse are sorted out together with rejects, and slaughtered following anaesthetisation and destroyed. Alternatively they can be sorted out together with the sorting of small fish and put to further use. If planning further use of the wrasse, it can be relatively easily retrieved with the aid of a dip net when the weighted net is being dragged. • Assess the merits of carrying out the above with wrasse at each individual installation, and use as a reference base.	
15. Registration:	
Cleaner fish are legally considered aquaculture animals, as stipulated in the (Norwegian) Regulations relating Operation of Aquaculture establishments (*Akvakulturdriftforskriften*), http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf - see section 10 for registration. • Wrasse releases: Supplier, date, species, size, number, catch area. • Dead fish: Number and species, possible or ascertained cause. • Blend percentage. • Termination of wrasse usage.	
16. Deviation management:	
• Report back to fisher/supplier in event of mortalities after delivery, and request compensation if mortalities exceed agreed levels.	

	Form
• Other common methods of deviation management if deviation(s) should occur.	

Fish welfare:

Many of the guideline's points are about fish welfare, and the recommendations given are mainly concerned with making certain the cleaner fish are well cared for, thus ensuring first-class quality fish. This is also decisive to the cleaner fishes' ability to function as intended at the marine farm.

Safeguarding against escapes:

- Follow the user manual for installing and elevating refuges and other equipment.
- Good routines for delivery of cleaner fish.
- Use minimum size measurement for livestock. The nets must have the correct mesh width.
- Use refuges that are not at risk of rubbing abrasively on the net.

HSE:

- Life jacket
- Other procedures that apply to the facility/installation.

References:

Norwegian Food Safety Authority (NFSA); on cleaner fish with reference to current acts and regulations:

- http://www.mattilsynet.no/fisk_og_akvakultur/akvakultur/cleaner fish/
- The Aquaculture Operation Regulations (translation): http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf
- The Norwegian Animal Welfare Act (*Dyrevelferdsloven*): https://www.regjeringen.no/en/dokumenter/animal-welfare-act/id571188/
- Norwegian Directorate of Fisheries; provisions, regulations, advice and guidelines (http://www.fiskeridir.no/)

Attachments (see www.lusedata.no for attachment):

- Example of contract between buyer and fisher of wrasse/cleaner fish
- Wall chart prepared by Stein Mortensen of the Norwegian Institute of Marine Research (NIMR)

Industry guidelines – sea lice

Subject:	Best practice guidelines:
Cleaner fish	**Catches and storage-in-transit of wrasse fish**

Prepared by:	Contact person:	Date:	23.02.2017
FHF cleaner fish project	Eirik Sigstadstø, FHF	Page:	**Page 27 of 62**

Objective:

To ensure optimum and sustainable access to wild catch wrasse of best possible quality for use in combating the marine farming industry's lice problem.

Description

17. Preparations:

Familiarise yourself with the current regulations:

Updates and clarifications pertaining to regulations regarding cleaner fish are currently under review. For the time being, see current regulations:

- The Regulation concerning Transportation of Aquaculture Animals: http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf, (hereafter called the Transport Regulations) which stipulates a number of requirements for welfare, equipment, the unit of transport and monitoring.
- Catches of wrasse are regulated by the Norwegian Directorate of Fisheries, and the regulations are uploaded on their website (http://www.fiskeridir.no/Yrkesfiske/Tema/Leppefisk) (only in Norwegian). This includes criteria and information on season opening dates and total quotas for fishing, escape openings in equipment, minimum size and criteria for participation in the fishing.

Vessel and catch equipment:

All equipment for the vessel and catches must be made ready for use before the catch season commences. It is vital to ensure the wrasse are handled as sensitively as possible, and wherever possible not removed from the water. There must be systems on board that provide good flow-through/replacement of water during the time the fish are in the vessel's tanks:

- The vessel shall have been approved by the Norwegian Food Safety Authority (NFSA), see Chapter 2 of the (Norwegian) Transport Regulations
- The sorting system, fishing equipment etc., must be examined to ensure that all surfaces are smooth with no sharp edges, with no crevices that may catch on fish fins.
- Holding tanks with lids, shall be organised with good water circulation, preferably with a back-up system in the form of a backup pump or option for oxygenation. There are many good solutions on the market. Ensure there are several compartments in the tank, and that there is good flow-through of water. A good holding tank must consist of several compartments/perforated grids to keep the different wrasse species separate, and to subdue water motion. But be aware that these restrict water circulation, so each compartment must have its own water supply. Alternatively, use several tanks.
- Wrasse must NEVER be left dry – organise a suitable sorting table, preferably with water circulating on it where catch equipment is emptied. Several solutions for this are available on the market. Modify according

Description

to the size and layout of the boat, number of crew on board or similar. The most important consideration is to ensure that all fish are handled sensitively, including those fish that are rejected. The outlet pipe should be installed below the waterline to avoid undersized fish that are discharged being eaten by seagulls.

- Install a refuge (in the form of e.g. a plastic kelp curtain) in the holding tank(s) on board the boat, as a means of providing the wrasse with an as natural and least stress-inducing environment as possible (see also under Refuges in storage-in-transit). Be aware that too many plastic kelp curtains in the tank will inhibit circulation. Alternatively, you can just use the lid on the tank to keep the tank in total darkness inside.
- Experience shows that a darkened tank with a lid results in less stressed wrasse.
- Remember to use a dip net. N.B. This must not be too deep or too large. Gentle handling can be achieved by just netting a few wrasses at a time. Too many fish in the dip net may result in losses, injuries due among others to crowding and punctures from fin points.

Catch equipment - general information:

Creel traps and fyke nets are available on the market that comply with current regulations for catches of wrasse. Fishermen recommend traps with the largest compartments (e.g. rectangular traps 80 cm) as they provide the most space for the fish and likely contribute to less wear-and-tear.

Criteria for catch equipment (regulated by the Norwegian Directorate of Fisheries):
Catch equipment shall be fitted with escape openings with minimum 12 mm column width. Moreover, the entrance barrier is required to have a smaller entrance so that a cylinder with a 70mm diameter can be drawn through the entrance. This is to prevent/reduce catches of otters, seabirds, larger fish, lobsters and crabs.

Some wrasse buyers only want fish caught with creel traps. Trials carried out by the Norwegian Institute of Marine Research (IMR) have not succeeded in showing any difference between fyke and creel-caught wrasse with regard to quality and survivability. Fyke nets should not be used in areas with many predators (especially cod). Round traps with small entrances are often used from Trøndelag and northwards, and otherwise if catches are concentrated solely on Goldsinny wrasse.

An illustration of two types of traps available on the market, and photo of a dip net.

Important points for choice of equipment:

- Catch equipment must be easily usable.
- Avoid sharp edges.
- Catch equipment must be made from finely meshed netting.
- Thick, smooth cords are useful (not knotted nets).
- Use clips to close off opening (knots are just bothersome).

Description

- Make certain that the catch equipment has the mandatory escape openings that provide undersized wrasse or bycatch species the chance to return to their natural habitat in the sea without unnecessary stress and handling.
- Install a crab barrier in the entrance to prevent/reduce large bycatches.

Avoid spread of infection:

- Wrasse and/or transportation water **shall not** be transported out from a site/area afflicted by outbreaks of disease. The Norwegian Food Safety Authority estimates a distance of 5 km surrounding the site as a reasonable 'quarantine' zone. Immediately after leaving an infected area the boat and equipment shall undergo thorough cleaning and disinfection.
- Prepare a plan for cleaning and disinfection of vessel and equipment, preferably in cooperation with the customer.
- Stay well-informed with chart updates of registered ISA (infectious salmon anaemia) and PD (pancreas disease) outbreaks: https://www.barentswatch.no/fiskehelse/ (in Norwegian/English) or https://kart.fiskeridir.no/akva (only in Norwegian)

Oxygen measurement instrument:

- Good oxygen conditions are vital in the holding tank. Installation of pumps that guarantee flow-through and continual replacement of water (200 litres per minute/m^3) in each compartment of the tank has proven a successful provider of good oxygen conditions to wrasse. If passing stretches of brackish water, levels of salinity must then also be monitored.
- Oxygen levels must be maintained at minimum 80 % saturation
- The oxygen data logger must be in position before the season commences, with personnel having received instructions on its use. Plan for logging to be registered at 5-minute intervals.
- Consider the pros and cons of using oxygenation; in particular with high sea temperatures.

Oxygen:

Wrasse become easily stressed during transportation and handling; which can cause a sudden decline in oxygen saturation in the fish tank. It has been observed that by merely removing the lid of the fish tank, and in a split second, the level of oxygen in the water has lowered drastically.

- Sea temperatures are highest in the period July – October, and high temperatures result in low oxygen levels in the sea.
- This coincides with the season for catches of wrasse. Monitoring of oxygen level in holding tanks is essential.
- Oxygen levels shall be measured and logged continuously. Documentation of an oxygen log is required by some buyers.
- As a minimum requirement, oxygen must be measured with high water temperatures and much fish, as a means to gain an overview of the catch vessel's holding tank capacity. The level of oxygen must never drop below 80 % saturation.
- An oxygen level below 80 % stresses the fish and can be the cause of mortalities at a later stage.
- There should be an opportunity, if the need arises, to add oxygen during transportation with high temperatures.
- When adding oxygen, avoid oversaturation by ensuring the oxygen level does not exceed 100 – 125 %.

Learn about the different species:

- Make yourself fully aware and familiarise yourself with the characteristics and needs of the various species of cleaner fish. Preferably keep reference material handy in the boat. Reference material may be readily found here: http://www.imr.no/filarkiv/2012/05/plansje_leppefisk.pdf/nb-no

Description

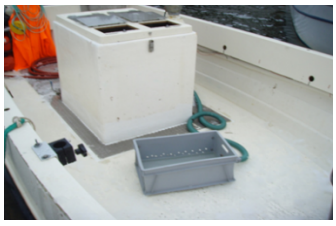
18. Implementation:

Catching wrasse:

- The fishing season is not opened until the spawning period is over. The date can vary from one year to the next, and is based on trial fishing under the combined regime of the Norwegian Directorate of Fisheries and the Norwegian Institute of Marine Research.
- Catch journal: The producer (fish farmer) should specify requirements concerning use of catch journal and reporting in the agreement established with the fisher. (See example of catch journal: http://lusedata.no/for-naeringen/veiledere-leppefisk/) The catch journal should also include registration of bycatches (otter, lobster, crab, cormorants or similar) and information about whether the species has completed spawning. Check requirements in the Transport regulations chapter 3 section 9.
- Catch equipment must be hauled up and checked at least once a day (preferably several times per day, depending on temperature and density of catch in the creel/fyke). When catches are plentiful, make sure you have enough capacity to take all of the catch with you!
- Slowly hoist the creel/fyke to prevent the fish "exploding". Adjust rate of hoist according to the depth, species, temperature and size. Maximum recommended depth for a fish trap is 6 meters.

Sorting of wrasse while at sea:

- The fish should be sorted in water on board, close to the place where they were caught.
- Separate according to species and size in different tanks, and record details in the counting log. The difference between "small" and "big" corkwing and ballan wrasse must be agreed upon in advance with the buyer. Escapes must be avoided at all costs; and the mesh width in the salmon nets determines the lower length limit. See table in *Guideline for use and management of wrasse.* Minimum size: see wild catch regulating practice for wrasse: Norwegian Directorate of Fisheries.
- Only use a dip net with handling/unloading the fish. Make sure you do not have too many fish in the net.
- Due to the risk of aggressiveness, it is worth considering sorting the ballan wrasse into groups of two different sizes. This applies to the fish when they are in the boat and in the storage-in-transit nets.
- Unwanted species, undersized wrasse, spawning fish and fish of inferior quality (look for nose and fin injuries in particular) should be released consistently close to where they were first caught. This is best achieved through sending the fish through pipes below the water's surface to avoid predators that are close to the shore – **THINK SUSTAINABILITY**. In this way you avoid filling the fish tank with fish not intended for delivery, and thus utilise space in the tank more efficiently.
- Damaged fish or fish with large sores or other indications of disease should not be released back into the sea, but killed with a blow to the fish's head.
- Once the tank is filled with the maximum number of fish, the catch is delivered to the depot/installation or to storage-in-transit.



Description



Storage of wrasse while at sea:

- Monitor and maintain good water circulation, use refuges in the tanks and a lid to lower stress levels in the fish.
- Long holding periods in a well or traps etc. should be avoided, particularly if the weather is bad, as this leads to nose sores and other 'wear and tear' on the fish.

Quality and weather conditions:

- It is important to take note of where the wrasse were caught. If fishing takes place in exposed areas, one must be extra vigilant with conducting quality checks after storms. Large waves and strong currents generate much movement in the fishing equipment. This can easily lead to wear and tear on the fish. If a large percentage of the fish are worse for the wear after a stormy period, then all fish should be emptied out/destroyed. This is because the blemish-free fish will have suffered extreme stress, and therefore will be of diminished quality. Sores will subsequently emerge later.
- For the same reason the fisher is required to avoid heading into big sea swells with fish in the well.

Storage-in-transit:

Storage-in-transit should preferably be avoided. If the fish cannot be delivered directly in a net, the following is recommended:

- Recommended maximum storage time 5 days. There is considerable risk of fish suffering major injuries after 1 week's storage-in-transit.
- Place the holding net in good storage sites with minimum waves, and with a steady current that ensures water replacement and good oxygen conditions. An overly strong current will stress the fish.
- Avoid placing the holding net in places with plentiful fresh water.
- Measure oxygen when the flow of water is at its lowest. Also during storage-in-transit the oxygen levels should be over 80 % saturation.
- Keep the holding net clean. This ensures good flow-through and good oxygen conditions.
- Use finely meshed storage nets of thick, smooth cord; 64 On[2] with smallest fish, and 50 On with the biggest.
- Perforated tanks may also be utilised. These should have a dark coloured interior.
- Typical size of a holding net is 3x3x3 m.
- Make certain there are sufficient weights on the nets to ensure that the net is taut.
- Use refuges – either artificial kelp or natural kelp.
  In order to facilitate quick and efficient emptying of the net, the refuges must be installed in such a way that they are easy to lift.
- Lower stress levels for the fish – use a cover/shadow net/canopy overhead.
- Consider possible needs for other measures against predators.
- Sort the fish into sizes BEFORE storing – big fish often "bully" the smaller fish.
- Density of biomass will affect quality; check oxygen conditions and wear and tear on fish.

[2] On – Norwegian mesh calculation: half the number of meshes per Alen (1 Alen = 628 mm)

Description

- Oxygen levels should be checked in periods with quiet currents, with many fish in the storage unit. The oxygen level determines the appropriate quantity of fish that can be stored in the unit.
- Remove damaged and dead fish on a daily basis, meanwhile taking care to not stress the live fish.
- Feed the fish during storage-in-transit. Feed especially for wrasse is available commercially. See Guideline for use and management of wrasse.
- Always check the holding net for holes when emptying. Prepare a plan for cleaning and disinfection of storage nets in collaboration with the customer.

With delivery directly to the salmon pen (Also see separate guideline Delivery of wrasse)

- The fisher arrives with the fish in accordance with the agreement with the works manager. Upon arrival a representative from the delivery location shall be present to check quality, size, number and species.
- The fisher shall provide a log showing O_2, temperature and catch method form.
- The fish are placed gently in a refuge in the pen, either with the aid of a pipe or the tank is lowered into the pen. Independent delivery stations placed in the salmon pen have prevented wrasse from seeking to descend to the bottom of the salmon pen, thus ensuring a far greater rate of survival. The delivery stations are fashioned in the shape of big, cylinder-formed kelp refuges or small nets with escape openings at the top.
- Ask how many days the fish have been stored in transit – these should preferably be released directly into the pen.
- Comment on things that are good or bad. This contributes to ensuring continual improvement.
- Cleaning etc. in the boat should considered (in accordance with procedures/previously defined criteria).
- The contract note is written, fisher and buyer each receive a copy that is filed. A third copy shall be supplied to the Sales Association.

19. Registration:

Follow the provisions as stipulated in the current regulations (see the Transport Regulation, chapter 3, journal entries) and agreements made with the buyer:

- Catch journal
- Contract note

20. Deviation management:

All deviations shall be dealt with

- All incidents and occurrences in connection with catches, storing, transport or delivery of the fish, and which may have had a negative effect on the fish/led to reduced quality of the fish, shall be registered in a deviation report. Measures already initiated to reduce the consequences of the deviation, or provisional measures to prevent the deviation from reoccurring, are also described in the report. A description is also provided of permanent (corrective) measures that have been initiated, or that are planned for implementation, to prevent similar deviations from reoccurring. The report is filed.
- Previous clarification shall be agreed on actions to be taken if there are major deviations in a delivery. The fisher/supplier shall be aware of the consequences.

Fish welfare:

Many of the guideline's points are about fish welfare, and the recommendations given are mainly concerned with making certain the cleaner fish are well cared for, thus ensuring first-class quality fish. This is also decisive to the cleaner fishes' ability to function as intended at the marine farm.

Safeguarding against escapes:

- Correct fish size.
- Good security and control with any holding pen(s).

- Notify the marine installation and agree on arrival time for delivery of the cleaner fish. Follow directions given by the marine installation.

HSE:

- Life jacket.
- N.B! Acquaint yourself with the necessary safety routines concerning use of oxygen.
- Agree on an arrival time with the installation that is receiving the fish, so that it is fully prepared to receive the delivery.

References:

Various guidelines and advice are available on the Norwegian Food Safety Authority's website. Guidelines are also provided on the Norwegian Directorate of Fisheries' website.

Attachments:

- Cleaner fish wall chart, prepared by Stein Mortensen of the Norwegian Institute of Marine Research (NIMR). http://www.imr.no/filarkiv/2012/05/plansje_leppefisk.pdf/nb-no (only in Norwegian)
- The Transport Regulations (link to applicable issue: http://www.fao.org/fileadmin/user_upload/animalwelfare/English_transport_of_aquaculture_animals_2008.08.01.pdf
- See example of catch journal at www.lusedata.no in cleaner fish guidelines list (Norwegian only).

Industry guidelines – sea lice

Subject:	Best practice guidelines:		
Cleaner fish	**Handling and transportation of lumpfish**		
Prepared by:	**Contact person:**	**Date:**	16.02.2017
Akvaplan-niva	Eirik Sigstadstø, FHF	**Page:**	**Page 34 of 62**

Background and objective:

The guideline's objective is to provide recommendations to procedures for handling and transportation of lumpfish. The recommendations are based on the analysis of the fishes' reactions to stress experienced in different conditions during transportation, as studied in the Norwegian Seafood Research Fund (FHF) financed project "Development of transport and delivery procedures for lumpfish based on mapping of environment and stress" (project number 901158). The guideline is a contribution toward improving the lumpfish's welfare, survival and function as lice consumer in salmon pens after completed transportation.

This is a guideline for closed containment transportation of lumpfish that offers recommendations only. The actual procedures must be developed locally for each individual enterprise, or for each facility/installation, in order to safeguard among other things adjustments made locally in relation to the environment, equipment etc.

Special conditions:

The guideline builds on the systematic mapping of transport conditions and physiological responses to handling and stress from transportation in both field and controlled trials, and input from fish producers, veterinarians and carriers. Three areas that should receive particular focus in creating a procedure for transportation of lumpfish are:

1) The lumpfish's characteristic behaviour under stress (crowding or attaching itself to a surface by a suction disc on its belly) makes it difficult to distinguish unstressed fish from stressed fish, as the lumpfish does not display a typical flight response as is the case with salmon. Therefore dependence is on measuring stress physiologically to expose the response. A lumpfish with "calm" behaviour can be stressed. If you lack actual data about lumpfish, then apply the same principles and limit values as for salmon.
2) Stress and any physical strain (loss of mucus and injuries) in connection with handling (loading and unloading from transport tank) are registered as significant stress factors for lumpfish, particularly with repeated handling in a short space of time, often in connection with secondary transport, which requires transhipping of fish. Development of quick, gentler loading and unloading methods should take high priority. An even better option would be to

look at methods and technological aids that can reduce the number of times fish are handled during transportation, primarily by avoiding unloading fish to secondary transport.

3) The lumpfish is a newcomer to fish farming and as yet the surface has barely been scratched on a species that is very different from what the aquaculture industry is accustomed to working with. It is therefore important to include good routines for reporting of deviations, log entries and systematisation of data in the procedures, to then utilise in developing data and expertise. Active use of deviation management systems is the best method by which to learn and improve.

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21. Development of procedures

This guideline is intended purely as input and as a recommendation concerning procedures for handling and transportation of lumpfish. Development of own procedures must take the following into consideration:

- **Requirements for risk mapping: Procedures shall be pursuant to the IK-Akvakultur regulation (https://lovdata.no/dokument/SF/forskrift/2004-03-19-537) (in Norwegian only) that is developed for individual facilities/installations/sites and is based on own risk assessment. The principal factors to consider are external environment (e.g. escapes), biosecurity, fish welfare and HSE.**
- **Installation-specific agreements, which shall be entered into between supplier and recipient, veterinarian, carrier, including any specifications e.g. in relation to quality of the fish and implementation of the transportation, may with advantage be included in procedures.**
- **It is recommended to attach a checklist as a safeguard where all relevant considerations have been included in the planning and implementation of the transport**.
- **The fish transporter shall comply with specific requirements, which is the fish producer's responsibility to follow up. These are briefly referred to in Attachment 1.**

22. Planning

Initial agreements:

The most important parameters that affect the quality and safety of the delivery should be clearly defined.

Examples of this would be: the transport method/carrier, fish size and number of fish per delivery (density during transportation), delivery location (transport time) and preferably time and date of delivery (temperature). The earlier these are taken into consideration, the easier it is to accomplish successful transportation.

Preparation for the delivery:

- **In good time before making the delivery, a thorough check must be made of equipment and internal logistics for readying the fish for transport and loading of a vehicle. Equipment such as delivery tanks, pumps, hoses, couplings, escape safeguards, counting apparatuses etc. must be checked and if necessary tested.**
- **A check should be made on whether any previous deviations are closed/improved.**
- **Oxygen and temperature measurement devices should be checked over and calibrated.**
- **If possible, steps should be taken early in the planning to safeguard against fluctuations in environmental factors throughout the transport process, particularly with regard to temperature.**

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- **If there is a need and an opportunity to install temperature acclimatisation to improve conditions for transportation, or for facilitating adjustment to temperature with release into seawater, this should preferably begin one week before the transportation.**
- **The transportation process at all times must be operated by sufficient experienced personnel who have clearly defined areas of responsibility.**

23. Preparation

Preparation of vehicle before loading:

- **The carrier must have documentation of completed cleaning and disinfection of transport tank(s) and calibrating of a data logger for pH, temperature and oxygen in the vehicle.**

- **Regulatory requirements (Attachment 1) stipulate that the driver shall have the necessary competence to attend to the fishes' physiological requirements, water quality and welfare. The producer must ascertain that the carrier has this competence.**

Preparations for delivery:

- **A good line of communication and division of responsibility must be established between the carrier and recipient in good time before delivery, in order to ensure correct manning, equipment and method for quickest possible unloading of the fish. The carrier and recipient must agree beforehand on the type of equipment that shall be available at the delivery destination.**
  E.g. applies to transport hoses (correct length) and couplings, water separator, fish pump (if needed) etc. with correct dimensions. There must be agreement between the carrier and recipient on the following; delivery location and access secured for the transport vehicle to the unloading site, manning and estimated time to be taken for unloading. The carrier must be informed on conditions such as tidal differences, weather conditions etc.

- **The recipient must plan for the arrival of the delivery that includes the following: preparing the pen(s) (e.g. matching mesh size in relation to fish size), retrieval of fish for quality control (delivery inspection), management of any deviations, and veterinary follow-up.**

Specifically for lumpfish:

Preparation of transport vehicle:

Lumpfish producers are of the opinion that darkened tanks are the best option for transportation of lumpfish, and that the fish should be kept in darkness as much as possible during transportation. This is to reduce aggression amongst the fish that can lead to increased levels of stress and fin biting. Remember that the fish have been starved before transportation and this in itself may lead to increased aggressiveness.

- **If possible, the carrier should use darkened tanks and keep the fish in darkness as much as possible during transportation. Any inspection hatches should have lids/covers.**

Fixed mounted gauge probe in water:

- **Lumpfish are able to attach themselves to the gauge probe in the tank, but in doing so affect the gauge's results. To avoid deviating values in environmental logging during transportation, gauge probes in the transport tanks must be protected with e.g. coarse meshed plastic netting or other material that prevents the lumpfish from attaching themselves to gauge probes.**

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24. Implementation

Preparing the fish for transportation

Fish biomass and quality:

Good control over fish biomass is a prerequisite for proper, verifiable transportation, as the quantity of fish that can be transported is governed by the fishes' biomass.

- **Accurate data on fish size and number is, therefore, a minimum requirement.**

Carefully sorted fish is also an advantage. A good overview may be achieved with the use of a fish counter or by counting during vaccination and having good control over mortality figures up to delivery dispatch.

The fish are often kept in larger tanks under transport, and a new head count must be carried out using either a fish counter or alternatively by volume by reading a scaled and calibrated plexi-glass water column affixed to the transport tank in order to achieve a precise view of the biomass. Otherwise the fish could be counted beforehand in separate delivery tanks designated to each transport tank. That way having to do a new count at loading time is avoided and loading will be a quicker and gentler process.

- **Fry and juveniles should be counted, possibly sorted and transferred to delivery tanks ca. 1 week before delivery, so that the fish are not subjected to new handling before being loaded onto a vehicle.**

- **A veterinary inspection must be made of the fish prior to the transport's departure. The health and origin certificate according to the form specified by the Norwegian Animal Health Authority shall be made available before transportation commences (Attachment 1). The certificate is valid for 21 days after the inspection.**
  Additionally, the customer may for reasons of special needs require the supplier to provide PCR analyses of the fishes' carrier status for selected pathogens that should be made available before transport commences. Mortalities that occur the last 30 days before transportation should be registered (in written form) and accompany the fish together with other production and handling history (CV).

- **If the fishes' mortality rate or health status changes, or changes occur in the fishes' behaviour a short time before delivery (after the last veterinarian's report), the veterinarian should be sent for and the customer notified.**
  Sick fish or fish with deviating behaviour that may be a sign of disease, or fish with a high instance of sores or fin wear-and-tear, should not be transported.

Starvation before transportation:

It is vital to starve fish before transportation to reduce environmental strain on the fish.
The problems are connected to faeces in the transport tank, in addition, the metabolism and thus oxygen consumption and excretion of CO_2 and ammonia downregulates so that environmental strain during transportation is reduced. The starvation period also contributes to the fish tackling handling better. Pollution from faeces can result in discolouration of the water, foam accumulation and fine particles in the water that can clog the fishes' gills and lead to gill irritations and a risk of reduced oxygen intake and regulation of the salt balance. Increased organic strain in the water also enhances conditions for bacteria to grow. How long one should starve fish is dependent on the species, size and temperature.

- **A period of starvation is especially important prior to long-distance transport. For slaughter-ready salmon this can be about one week, while juveniles and smolt are usually starved for 2-3 days.**

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Cold-blooded fish normally require a longer starvation period at low temperatures than at a higher temperature. How long it is defensible to starve the fish depends on any negative effects that may occur to fish welfare (stress, development of aggression and fin biting) and finances (loss of biomass).

Specifically for lumpfish:

Starvation:

- **Starvation period: 2-3 days starvation is recommended for small lumpfish (30-60 g) in darkened surroundings at around 8 °C before transportation to reduce environmental strain during closed containment transportation.**
  The starvation period should take into consideration size and temperature (reduced starvation period at higher temperature and smaller fish size). Even if a fish is starved for a longer time, it can still have faeces in its intestine because the digestive system downregulates together with another metabolism.

- **Light intensity during starvation: Aggression and fin biting are common problems with hungry fish. Fish producers alleviate this by keeping the lumpfish in darkness during the starvation period.**

  Plasma cortisol has been measured in lumpfish as an indicator of acute stress before starvation, and 2 and 3 days respectively after starvation in darkened surroundings at around. 8 °C, without this having affected the level of stress. Fish producers have also had good results with a starvation period lasting 3-4 days with subdued lighting.

Loading into vehicles

- **Biosecurity: Biosecurity must be carried out before loading by the carrier documenting that regulation cleaning and disinfection has been carried out on the vehicle and transport tank(s). The supplier must comply with internal procedures for biosecurity.**
  - *This is the principal prerequisite for preventing any spread of infection.*

- **Calibration: Before loading the carrier must provide documentation of correct maintenance and calibration of all required logging devices for water quality (oxygen, pH and temperature).**

- **Water quality: Before loading, the transport tanks are filled with water that is as similar as possible in salinity and temperature as the fish have been acclimatised to, preferably from the same raw water source as for the juvenile facility.**
  - *The tank water can profit from being filtered (minimum 60 µm), UV-treated and aerated. It is vital to have data available of UV dosage and adjustment in relation to any pathogens known of from the facility/installation. For example, a dose of minimum 2 mJcm-2 may be needed to combat the amoeba Neoparamoeba perurans, which is a widely known problem for cleaner fish.*
  - *Oxygenation and the ventilation system in the transport tanks are tested prior to loading and monitored closely during the entire loading process for any regulating that may be necessary to maintain 100 % oxygen saturation. The water environment is registered and logged frequently (or logged automatically) from the commencement of loading.*

- **Safeguarding against escapes: Before all moving of the fish, the installation and process must be secured with regard to fish escapes, e.g. double safeguarding the couplings of the transport hose and water separator, and placement of strainers in the drain.**

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- **Drainage system: As the transport tanks are filled up beforehand with clean water, a drainage grid is utilised with transfers to transport tanks so that production water from the delivery tanks does not mix with the clean water as this can cause deterioration of water quality (has heightened levels of CO_2 and total ammonia (TAN)).**

- **Crowding and loading time: Total loading time should be completed as quickly as possible.**
  - *If salmon are crowded more than three hours this prompts a stress response that lasts longer than for shorter crowding. Distributing the fish in several and smaller delivery tanks facilitates swift emptying of the tanks and gentle handling of the fish (less crowding together), and simultaneously minimum loading time for the entire transport. Experience shows that the last transport tank to be loaded onto the trailer is often the "worst" (least transport tolerant).*

  - *Lumpfish have spikes and these can easily develop sores for injuries sustained in crowding. In larger tanks, grids may need to be installed to prevent crowding. Water must be constantly replaced in the tank during crowding and pumping, and there must be opportunity for supplementary oxygenation to ensure oxygen saturation is around 100%. All movements must take place slowly and carefully.*

- **Pumping: Correct use of fish pump and fish counter in relation to well-established procedures and equipment is crucial to avoiding loss of fish mucus, sores and injuries to the fish that can provide entry to infections and an increase in mortalities.**
  Vital factors: Correct speed for fish pump and accurate dimensioning of pump and transport hose in relation to fish size. Injuries occur particularly with repeated pumping, under-dimensioned pump, incorrect constructions and incorrect installation of pumps and hoses with edges, vents and tight pipe angles. No studies have been undertaken for lumpfish, but tests with salmon smolt show that as pumping speed is increased (0.9 m/s < 1.4 m/s < 2.3 m/s) loss of scales also increases, and it is recommended to not pump smolt faster than 2.3 meters per second.

- **Dip netting: Dip netting usually prompts more stress than pumping and adds a higher risk of causing mucus loss and sores that can affect the fish negatively after release into the sea (pen). If dependent on dip netting this should be done with a tarpaulin-net (hand net). Knotted hand nets must never be used. The process requires experienced, trained personnel.**

- **Use of sedation: There are some doubts about the use of sedation to reduce stress during handling.**
  - *Sedation is recommended for salmon in situations with much stress, but also with a warning against repeated and long-term usage.*

- **Control of oxygen: Under loading one person (usually the carrier) should be assigned to frequently carry out measuring and adjustment of oxygen in the transport tanks. The level of oxygen should be maintained as far as possible around 100 % saturation.**
  In connection with the loading process, the fishes' level of activity will normally increase and subsequently trigger a risk of significant fluctuation in oxygen saturation in the transport tanks if this is not managed in time to adjust for this. Meanwhile, oxygen consumption often varies between transport tanks due to different loading times/acclimatisation period. Not all carriers have an oxygen probe in all transport tanks that provide automatic logging.
  Both oversaturation and inadequate saturation of oxygen may result in sub-standard fish welfare. The toxicity of ammonia increases with a reduced level of oxygen, and a high oxygen level can cause

Description

oxidative stress (and reduce the rate of ventilation in respiration) and thus reduce aeration of CO_2 from the blood (leading to hypercapnia and a reduction of pH in the blood).

Specifically for lumpfish:

Crowding and pumping: It is recommended that draining of tanks, any steps taken to relieve crowding and pumping of fish over to transport tank(s) are carried out as quickly and sensitively as possible. Detailed procedures should be prepared that are tailored to the requirements of the individual location/installation, with a full description of how this is done. *One challenge with the lumpfish when it becomes stressed is that it attaches itself to surfaces, in tanks and transport hoses, and can be difficult to prise loose. Steps should be taken to prevent this occurring, thereby avoiding having to use a broom/brush or a powerful jet of water to jolt the fish loose.*

Even if lumpfish do not display a "classic" stress response as shown by salmon with increased swimming activity and flight behaviour, it may exhibit "pressure behaviour" where it attaches itself by suction to surfaces. The lumpfish demonstrates a clear, acute stress response, which is measured as an increase in the stress hormone cortisol when it is stressed. Measuring of plasma cortisol under commercial transport has shown that handling has triggered stress in connection with loading for transportation (primarily crowding and pumping) and that this accounts for the most significant cause of stress in connection with transportation (Jonassen m.fl. 2017). Transfer of lumpfish from the delivery tank to transport tank on a vehicle by use of a fish pump via a fish counter revealed that this procedure resulted in a doubling of plasma cortisol from average 24 (± 22 SD) to 49 (± 29 SD) ng/ml.

A series of controlled experiments on lumpfish (Remen m.fl. 2017) has also shown that maximum stress response occurs in connection with loading, where the stress hormone cortisol increased on average from 27 to 83 ng/ml in the course of the first hour (data from 5 experiments). After this, the level sank gradually to 53 ng/ml during 8 hours transport, despite a gradual reduction in water quality in this period. An increase in plasma cortisol (57 ng/ml) was also observed after 1 hour in lumpfish that had only been subjected to one transfer between two identical fish farm tanks, but in contrast to the transport groups the increase was more moderate and the level of plasma cortisol sank rapidly in the next few hours.

- **Pumping speed: It is essential to maintain a constant, stable flow of water in the transport hoses to prevent fish from adhering to surfaces.**
  - *The speed at which water is pumped can be critical for stress, and not least the risk of loss of mucus and injuries to the fish. It is not known what the optimum pumping speed is for lumpfish.*

- **Counting: It is recommended that all fish are counted beforehand and that distribution of biomass between transport tanks occurs via a volumetric reading of biomass in each tank.**
  - *Experiences with the counting of lumpfish are varied, but with many reporting that counting takes a lot of time, which poses a problem in relation to loading as this needs to be carried out quickly.*

- **Sedation (light anaesthetic): Sedation should be used with caution and should not be part of a preferred strategy in relation to streamlining loading for transport.**
  - *Sedation is used by certain producers in connection with the handling of lumpfish to prevent them from adhering to surfaces, while other producers have found that sedation specifically aggravates the problem of lumpfish self-adhesion. The indications are that sedation by the use of Aqui-S can cause increased stress in lumpfish, but this needs further investigation. The dosage most commonly used for sedation is 4 mg/m^3.*

  - *For short secondary transportation there is a possibility that sedation can still have an effect after transfer to a pen, and thus influence how the lumpfish adapts to the pen. As yet there is no data available on the effect.*

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- **Supplementary documentation: It is recommended therefore, in particular, to register incidence of sores of the fish before and after transport, in addition to other blemishes/defects.**
  Lumpfish research is in its early stages, and there is a need for systematic collection of data. There is some uncertainty as to the cause of fin wear-and-tear and sores on vulnerable lumpfish.

Transportation by vehicle

General information: Changes in water quality present the greatest challenge during closed containment transportation and is the factor that has the greatest impact on the fish's metabolism. Measures must, therefore, be implemented in closed containment transportation to reduce metabolism, with the aid of change in biomass density and temperature. Without water replacement, an accumulation of metabolites occurs with

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for instance total ammonia (TAN) and CO_2, an increase in particles from faeces and mucus etc. (TOC = total organic carbon) and reduction in pH. The percentage of TAN that exists in toxic form as free ionised ammonia (NH^{3+}) increases with an increase in pH. pH is affected by the accumulation of CO_2, which is secreted by the fish quicker than TAN, but accumulates later since proper aeration of the water releases a large percentage of CO_2. Reduced pH (with increased CO_2) contributes to a smaller percentage of toxic ammonia (a smaller percentage of TAN that exists as ammonia is absent for toxicity).

The practice of maintaining good fish welfare under transportation requires considerable knowledge about the causes of variations in water quality and how they affect the fish. A brief description of the significance of the principal water quality parameters under transportation, and recommended limit values for various environmental parameters, are provided in:

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- **An acceptable length of transportation time must be weighed up against the risk of sub-standard water quality occurring that increases through factors such as temperature, biomass and transportation time calculated from the time loading commences to completion of unloading.**
  The principal cause of stress connected to transportation is crowding and the process of loading to a vehicle. When the fish are transferred to a transport tank, they will eventually calm down as long as water quality is favourable. Short distance transport with short intervals between handling (loading, unloading and transfer to a new environment) increases the risk of stress build-up, while longer transport gives the fish a better chance of calming down before the new handling (unloading).

- **If possible (long-term) planning should be undertaken to avoid transport that involves travelling very long distances between the juvenile production unit and the location for final release.**
  Regulation of temperature and fish density affect the fishes' tolerance for long-distance transportation in that a lower temperature and lower density separately or in combination provide a justifiable opportunity to lengthen transportation time.

<u>Regulating of water quality under transport:</u> Control of water quality under closed containment transportation is first and foremost dependent on systematic preparation such as an adequate starvation period, low density in tank(s), temperature regulation of water etc. It is important to be able to adjust the level of O_2 under transportation, which should remain stable at 100 %, and to regulate aeration of the water. If there is a rapid drop in the level of pH, then aeration should be increased accordingly.

- **With long-distance transportation where the percentage of TAN can be high, it is crucial to keep control over pH, among others through regulating aeration, in order to keep the level of ammonia concentration low. With possible risk of high TAN, pH should be lowered preferably to pH 7.1**
  If there is a risk of high ammonia concentration, aeration can be reduced in order to sink pH so that the percentage of toxic ammonia is reduced. In these situations there should be extra alertness to the risk of increased CO_2-concentration.

- **Reduce transportation time in periods of high temperatures.**
  Temperature is also a factor to consider with transportation time, for both impact on metabolism and tolerance for ammonia. The metabolism and secretion of TAN increases with rising temperatures, at the same time as the toxic effect ammonia has on fish is higher at low temperatures than with high. Generally, margins are safer for transportation with low temperatures than with high (within the fishes' tolerance limits for temperature) as the fish then secrete less ammonia, but also there must be awareness that tolerance to ammonia diminishes with a drop in temperature.

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- **Risks associated with seasonal variations should be assessed, especially prior to long-distance transportation where the effect of the climate is greatest**
  Seasonal and weather conditions: Seasonal situations can occur under transportation where undesirably high temperatures in summer cause a problem due to the accumulation of ammonia, and similarly in winter where low temperatures cause the fish to have less tolerance for ammonia. Where there is a risk of temperature fluctuations, biomass density should be reduced under transportation.

- **Fish size and density: Big fish generally secrete less TAN than small fish. To compensate for this it is normally the practice to reduce biomass of small fish under transport, in contrast to the practice with big fish.**
  Recommended density for different fish sizes varies according to for example species, temperature, control and regulating of water quality, duration of transportation and the fishes' robustness. Therefore allowance should be made for a generous safety margin.

- **Control of water quality: Regulatory requirements for automatic monitoring and logging of oxygen in closed containment transport. This should be carried out in several tanks, and particularly in transport tanks with high fish density.**
  Automatic regulating of oxygen is also recommended. The level of oxygen under closed containment transportation is relatively simple to regulate to around the optimum of ca. 100 % saturation through oxygenation in combination with ventilation. Ventilation facilitates stabilisation of oxygen as it enables the excess oxygen to be eliminated.

- **Replacement of water under transport: It is not recommended to replace water in transport tanks under closed containment transport.**
  The reason is a pronounced risk for acute ammonia poisoning that occurs if "old" transport water with low pH and high content of TAN is mixed with "new" water with high pH. This causes an increased level of pH in water with a high content of TAN, which later leads to an increase in the amount of toxic ammonia.

- **Supervision of fish: It is recommended to check on the fish under transport, for signs/observation of deviating behaviour, foaming, particles in the water and other deviations.**
  The carrier must have adequate knowledge on how to make appropriate adjustments and take measures to ensure the fishes' welfare, to make special preparations for delivery, and ensure samples are taken upon delivery to reveal the cause of any deviations. The regulations require the carrier to be competent on fish welfare under transportation.

- **Taking of samples: Bottles and chemicals for taking samples of water quality (TAN, CO_2, pH, TOC) should be kept in the vehicle if documentation of the above is required after transportation, and in the event of any unforeseen incidents.**

Specifically for lumpfish:

<u>Water quality:</u> There is no data available that is specific for any lumpfish species with regard to water quality tolerance and limit values. Achieved water quality in controlled transport experiments with lumpfish is provided in the table below. Stress response for lumpfish in some of these experiments was possibly affected by water quality, but water quality was not considered a problem as the fish recovered their health within 24 hours after completing transport. The table represents therefore a set of water quality parameters that are anticipated as tolerable to lumpfish given the conditions under transportation.

Table: Changes to water quality after concluded transportation as a result of changes in transport conditions. Standard conditions for transportation are: Transportation time 8 hours, water temperature 8 °C, salinity ca.

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33 ppt, density 30 kg/m^3, fish size 30 g, 100 % oxygen saturation, 2 days starvation before transportation. A single parameter was changed each time with the five experiments; transportation time (20 hours), density (60 kg/m^3), water temperature (12 °C), fish size (60 g) and oxygen saturation (150 %). One particular parameter that could have almost qualified to act as a standard for all five experiments, was the effect of aeration on transport water, which affects CO_2 concentration and thus pH and ammonia (NH^3-N).

Transport	Endring	pH	TAN mg N/l	NH_3-N µg/L	CO_2 mg/l	TOC mg C/l
Standard	-	7.5±0.1	0.5±0.0	1.3±0.1	6.4±0.5	3.1±0.3
Økt transporttidtid	20 timer	7.4±0.0	1.6±0.1	4.4±0.1	8.6±2.8	4.9±0.1
Økt tetthet	60 kg/m^3	7.1±0.0	1.3±0.0	2.3±0.1	7.5±0.3	8.2±0.3
Økt temperatur	12 °C	7.8±0.0	0.8±0.0	3.3±0.1	4.9±0.3	3.4±0.0
Økt størrelse	60 g	7.6±0.0	0.3±0.0	0.7±0.0	5.8±0.6	2.5±0.2
Økt oksygenmetning	150 %	7.5±0.0	0.5±0.0	1.1±0.0	6.4±0.8	3.7±0.2

- **Oxygen (O_2): Aim to achieve as stable a level of oxygen saturation as possible (ca. 100 %) for transportation of lumpfish. Stabilising oxygen saturation at this level is dependent on having an aeration system in the transport tank(s).**
  High oxygen saturation causes gill damage, oxidative stress that results in mortalities after transport. In controlled experiments with lumpfish, it was observed after an 8-hour transport that stress (cortisol) had increased with 150 % oxygen saturation, compared with 100 % saturation. There are some doubts as to how this would develop over longer transportation. No good reason has been offered to practise high oxygen saturation under transport; the highest value that has been observed in commercial transport is ca. 120 %.

- **pH: In order to reduce ammonia toxicity, it is recommended to keep pH at a low level, particularly with longer transportation, but not lower than pH 7.1.**
  In controlled experiments with lumpfish it was observed that pH in the transport water dropped during the first 2-4 hours, but stabilised after that. Reduced pH in closed containment transportation is a result of the fishes' CO_2 secretion that increases with intensified biomass density, temperature and transportation time. pH can be regulated to a certain degree by regulating the intensity of ventilation in the transport tank(s).

- **Carbon dioxide (CO_2): As no data exists on tolerance limits for CO_2 in lumpfish, it is recommended to use the Norwegian Food Safety Authority's maximum limit of 15 mg/l CO_2 as the basis.**
  Even with the lowest pH (7.1) in experiments with lumpfish (with density 60 kg/m^3) CO_2 concentration was only 5 mg/L, significantly lower than limit values for salmon. CO_2 secretion increases with rising temperatures, meanwhile it is easier to ventilate CO_2 at high rather than low temperatures.

- **Ammonia: There are no established limit values for lumpfish, but the recommendation for setting limit values for NH_3^+ for lumpfish is the same as for salmonids in seawater, which should not exceed 12-25 ug/l** (Terjesen m.fl, 2013). **Lumpfish may possibly be less tolerant since measured pH in the blood of transported lumpfish is higher than that which is normal in salmon. Ammonia toxicity increases, as is known, with an increase in pH.**
  Experiments with lumpfish show, as anticipated, that an increase in fish density and transportation time leads to increased accumulation of total ammonia (TAN), including the most toxic for NH_3^+. Tolerance limit values are normally stated as NH_3-N concentration.

- **TOC: No data is available on tolerance limits concerning TOC for lumpfish, but if after transportation it is observed that mucus and foam have accumulated in the tank(s), then**

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gill health should be examined at the delivery inspection and followed up later when the fish are in the sea pen.
The stress caused by particles and other organic material measured as total organic carbon (TOC) increased with intensified fish density in experiments with lumpfish and was observed together with mucus formation in transport tanks. Clogging of the gills by mucus and particles contributes possibly to increased problems with oxygen intake, osmoregulation and gill infections.

- **Temperature premises: It is recommended to transport lumpfish with temperatures that are constant between 8 – 12 °C. Rises in temperature up to ca. 15 °C can be tolerated under transportation, also from the time transportation is completed to the actual release into the pen, but the lumpfish should not be subjected to significant drops in temperature under transport.**
  Simulated transportation of lumpfish (ca. 30 g) at 8 and 12 °C respectively under controlled conditions revealed that an increase in temperature from 8 to 12 °C resulted in minor changes in water quality, and there were no measurable differences in acute stress response (plasma cortisol) or secondary stress responses (plasma-pH and osmolality). This indicates that an increase in temperature from 8 to 12 °C does not result in either major changes in metabolism or tolerance to stress.

  Measurements from commercial transportation of lumpfish made under different temperatures showed improved tolerance to stress with rising temperatures in the interval 3.3 to 15.9 °C. Lumpfish also appeared to tolerate abrupt transitions from low to high temperature (from ca. 8 to 15 °C). Abrupt changes from low to high temperature (from ca. 8 to ca. 3 °C) can, on the other hand, prove more of a challenge to lumpfish. This is a situation that can occur under long-distance transportation in winter.

- **Light: Lumpfish should be kept in darkness as much as possible under transport. Any inspection hatches should be covered.**
  Lumpfish may become increasingly aggressive under transportation due to prior starvation. Experience shows that aggression can be curbed by keeping the fish in darkness.

- **Fish size: A lower density is recommended for small fish than for big fish.**
  The recommendation is based on general data ascertaining that small fish have a higher metabolism than large fish. Large fish are also generally more tolerant of transport stress and sub-standard water quality than small fish. Controlled experiments show no clear difference in tolerance for transport stress between lumpfish of 30 g and 60 g.

- **Biomass density and transportation time: A general principle with transportation of lumpfish - as for other fish – should be to reduce biomass density with increasing transportation time to reduce the risk of unacceptable stress due to the fish being subjected to sub-standard water quality.**
  Similar to general observations of closed containment fish transport, in controlled transport experiments with lumpfish a change was observed in water quality through an increase in biomass density and duration of the transport, but this did not appear to affect the fishes' physiological state negatively. At the end of transportation, the level of plasma cortisol was equally as high at 30 kg/m^3 as for 60 kg/m^3, and back to the before-stress level in the group that was transported in a 20-hour long journey. This applied to 30 g fish at 8 °C with good regulation of aeration (pH 7.4 – 7.1) and oxygen (100 %). Neither did analyses of water quality under these conditions provide any grounds to believe that water quality was critical under these conditions, based on criteria and data on water quality for salmon. Under good transport conditions for lumpfish around 30 g where there was an increase in density from 30 to 60 kg/m^3 and an increase in transportation time from 8 to 20 hours, only minor changes were noted with regard to stress response. Changes in transportation time and fish density have little influence lumpfish transportation as long as water quality is maintained within

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the recommended limit values. However, one must be aware that water quality is affected precisely by, among others, fish density and transportation time.

A follow-up of 15 commercial transports of lumpfish shows that if a routine practice is established for transportation of lumpfish of 20-60 g in densities from 30 – 50 kg/m^3 for up to 20 hours (more in some cases), the water quality under transportation and fishes' stress response appear to be satisfactory and in accord with results of controlled experiments.

- **Supervision of fish: Routines should be implemented for supervision of fish under transport.**
  Lumpfish behaviour is clearly distinctive from that of salmon and wrasse. The carrier should, therefore, be well informed specifically about lumpfish and have experience with lumpfish behaviour.

Delivery by vehicle (unloading from vehicle)

Unloading of fish is considered a critical phase of the transport and can often result in significant stress and major changes in the water environment, particularly with release directly into the sea (farm pens/marine enclosure).

It is therefore vital for good fish welfare that unloading takes place as quickly and sensitively as possible. General conditions to take into consideration:

- **In general, fish that have had the longest stay in the vehicle should be transferred first, or first from the transport tank with the biggest reduction of water quality (pH).**
- **The method of transfer must be as gentle as possible, preferably by gravity drainage in a flexi-hose/pipe. A tarpaulin net must be used if dip netting is required.**
- **When pumping ensure that the pump has the correct dimension and is tested to ensure it is set for the right speed. Excessive speed or pressure can harm the fish.**
- **Avoid extremes in height and fish colliding or coming into contact with sharp edges and hard surfaces that can cause loss of mucus and sores.**
- **Avoid fish coming into contact with air, particularly when temperatures are below freezing point.**
- **Water separator: To avoid the risk of acute ammonia toxicity, due to the mixing of old transport water with new water, a water separator should be placed at the end of the unloading hose to filter old transport water.**
  This is especially important where fish are being transferred to a fish farm tank or new transport tank or fish well for further transportation out to the fish farm installation. It is less critical when the transfer is made directly to the farm pen(s).
- **Flushing of the tank(s): Emptying transport tanks of fish often requires post-flushing with water. In order to avoid the risk of ammonia toxicity through mixing old transport water with new water, there should as little old transport water as possible left in the tanks when post-flushing is started, or post-flush with transport water (recirculate or take from other tanks when draining).**
- **Ensure the fish are not left dry, out of the water, or pile up in the transport hose.**

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- **Quality assurance: To be able to detect deviations that are important to learn from in order to improve the transport procedure, and make decisions in relation to deviations, one should have routines for delivery inspections and ready access to systematically logged registrations**
  Examples of this are as follows:
  - *Obtaining of consignment notes, health and origin certificate and fishes' history (normally sent in advance).*
  - *The vehicle's environmental log is collected on arrival, and quality checking (calibrating) of environmental data is carried out with manual logging, primarily of O_2, temperature and pH.*
  - *In a learning phase and in certain cases/situations (long and deviating transportation, with deviation in the behaviour of the fish etc.) it can pay to take water samples for analysis of TAN, pH, free CO_2 and TOC.*
  - *A visual assessment should be made of water quality in the transport tanks in relation to colour, particles, foaming etc., and fish behaviour before unloading.*
  - *30 fish should be retrieved for control measurement, visual assessment and scoring of key quality criteria such as loss of mucus, skin erosion, sores, fin wear-and-tear, deformities, cataracts, and gill inspections.*
  - *The smallest fish must be measured for size to verify that the pen where the fish are to be released has the correct mesh size (to avoid escapes).*
  - *Ensure that the delivery of the fish is supervised by an experienced representative of the recipient.*

- **Final work details: In order to prevent any spread of disease it is essential to wash and disinfect equipment, tanks and means of transport with approved chemicals and user dosage. Substantiate with signed quality assurance documents.**

Specifically for lumpfish:

- **Sedation (light anaesthetic): Sedation should be administered with caution and not be a part of a preferred strategy for unloading of fish from a vehicle.**
  In research carried out in the field (follow-up of commercial transport), a weak dose of Aqui-S (4 mg/m^3) was utilised as sedation to prevent lumpfish from attaching themselves to tank walls and inside the transport hose in connection with unloading from the transport tank. Compared with emptying procedures where Aqui-S was not used, the fishes' stress level was considerably higher (144.5 ng/ml, SD ± 47) compared with unsedated fish (59 ng/ml, SD ± 21). With short, secondary transport there is a risk that sedation could still have an effect after transfer to the pen, and thus affect the fish in acclimatising to the new environment.

  Experience shows that a good way to dislodge lumpfish that attached themselves by suction to tanks and transport hose is to carefully rinse with salt water.

- **Short, secondary transportation that involves transhipping and handling of fish within short time intervals should be avoided.**
  With lumpfish and wrasse, in particular, unloading often takes place from a vehicle over to tanks on a boat or to a smaller well boat for further transportation out to a pen (secondary transport). Data gathered from the field and controlled experiments clearly show that secondary transportation with the extra handling and environmental transitions causes considerable extra stress for the fish. Measurements generally showed the fishes' stress level (cortisol) to be three times higher after secondary transport compared with after primary transportation.

  Another factor with secondary transport is that the fish are often transferred to tanks that are smaller than transport tanks on the vehicle (primary transportation). If the fish from each individual tank in the vehicle are not distributed to several of the smaller tanks in the secondary transport, the result

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will be significantly increased fish density under secondary transport. This is a common phenomenon that is extremely risky and should be avoided.

Secondary transportation by vessel

After primary transportation, wrasse are often unloaded over from vehicle to vessel for secondary transportation out to a marine farm pen for release. This frequently occurs via transport tank(s) placed on the deck of a work boat, and the time taken for transporting time is often very short (normally 1/2 to 2 hours). Little is known about this type of transhipping and secondary transportation for salmon and other species, and the method and knowledge in this area are primarily based on experience gained from transportation of lumpfish.

Obvious risk factors linked to secondary transport are the extra handling the fish receive with transhipping, and the short time they get to calm down (reduce stress) before new handling with the transfer to a marine farm pen. Cumulative stress is connected to a heightened risk for mortalities after release into seawater, loss of mucus and sores that result in osmotic stress and enabling entries for infections.

Observations often reveal that the method and equipment in use under secondary transportation of lumpfish are inadequate in ensuring good water quality and fish welfare. Extraordinary consideration and critical factors for lumpfish are provided below.

Specifically for lumpfish:

Research into transportation of lumpfish has shown that secondary transport usually resulted in triple the stress level compared with the level after completed primary transportation. Extremely high fish density was often observed during secondary transport (up to 83 kg/m^3) and highly variable oxygen conditions.

In controlled transport experiments with lumpfish (30 g, 100 % oxygen saturation, density 30 kg/m^3 and 12 °C), secondary transportation was simulated by the lumpfish – following an 8-hour transportation – being transferred to a new transport tank for 1.5 hours under good transport conditions (100 % oxygen saturation, good water quality, density 30 kg/m^3, 12 °C). After secondary transport, the stress level had risen, but not significantly higher compared with the level after primary transportation, and at a far lower level than was measured 1 hour after transfer to the primary transportation (loading stress). This indicates that the cause of the extreme increase in stress after secondary transportation in the field (commercial transport) may be connected to the environmental conditions in transport tanks.

Storage-in-transit on board a well boat (small and often with special adaptations for lumpfish) normally provides the fish with plenty of space and water flow through in good environmental conditions. Risk factors and procedure input are not explored any further here, except to state that procedures must be in place that are based on normal risk assessments made in relation to the external environment (escapes), biosecurity, HSE and fish welfare.

<u>Tank(s) and outfitting of the tank(s):</u> Secondary transportation in tanks on a vessel (work vessel) is now the most common practice for lumpfish. The principles for tanks and tank outfitting on vessels should initially be the same as for a transport tank(s) on vehicles, but these often fall short of the requirements for environmental logging (O_2, pH and temp), oxygenation and aeration. Alternatively, it can pay to organise the pumping of water and flow through inside the tanks. This requires adequate pumping capacity and possibly adding some oxygen. Oxygenation in the transport tank on the vessel directly by aeration stones in the tank and without aeration of the water is advised against, especially due to the high risk of hyperoxygenation that can cause severe injury and have an acute impact on the fish.

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- **Requirements for tank environment, logging of water quality and regulation (oxygenation and aeration) are the same for secondary transportation as for other closed containment fish transport (primary transportation), Attachment 1.**

- **Tanks sizes should be the same on the vessel as the vehicle so that whole groups can be transferred without risking high densities under secondary transport.**

- **The tanks should have lids, to reduce stress and as a safeguard against escapes.**

- **Emptying detached tanks on vessels involves either the use of straps on transport tanks and hoisting over to the pen before emptying by sinking into the seawater, or emptying via a transport hose.**

- **If knot-free, finely meshed plankton cloth covers have has been used in the tanks during short transportation, this can facilitate the transfer to seawater in that the lumpfish are then unable to attach themselves by suction to the tank walls.**

Delivery direct to pen

- **The transfer to the pen(s) must occur in accordance with one's own procedure for safeguarding against escapes.**
- **Ensure against escapes by double-checking that the pen's mesh width is the right size in relation to the smallest size fraction of the actual delivered fish, and couplings and equipment must be doubly secured against breaks that can result in escapes.**
- **The pen must be erected in accordance with other special requirements/criteria.**
  Example: it was common practice with cod fishing to hoist up the tip of the net in an effort to avoid mortalities due to exhausted fish crowding together on the bottom. For cleaner fish, it is vital to place refuges and feeding stations in advance and place these correctly in relation to where the fish will be released into the pen. This must be defined beforehand in one's own delivery procedures.

- **Conditions such as strong sea currents and bad weather with choppy seas can be decisive to the success of a transfer to marine farm pen(s).**
- **Timing in relation to tidal flows may be crucial. Postponing the timing for releasing the fish by a few hours can in some cases prove beneficial.**

- **It is relatively easy to observe the fish at the time of release and based on experience make an assessment of fish quality (robustness, whether the fish have been injured or stressed under transportation). These observations, together with the environment in the pen (temperature, O_2, sea current conditions etc.), should be registered.**

- **Mortalities and appetite should receive special attention for the first 30-60 days with regard to building up experience on how these are affected by transport conditions.**

Specifically for lumpfish:

- **See "Guideline for use and management of lumpfish" for supplementing directions on preparations for lumpfish in farm pens.**

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- **Pen preparation: Lumpfish should only be released into clean pens.**

- **Safeguarding against escapes: Before transferring to the pen the size (height) of the fish should be checked and measured to ensure that they cannot pass through the net mesh in the pen, i.e. ensure that the mesh width is the correct size so that there is no risk of escape, even by the smallest fish. Accurate sorting of sizes is important for ensuring good control. The table for the choice of mesh type in relation to "height" of the lumpfish is shown below.**

Omfar	Halvmaske	Helmaske	Høyde
			Rognkjeks
40	15,5 mm	27,5 mm	21,9 mm +
38	16,5 mm	33 mm	23,3 mm +
35	18 mm	36 mm	25,5 mm +
32	20 mm	40 mm	27,6 mm +
30	21 mm	42 mm	29,7 mm +
28	22,5 mm	44 mm	31, 1 mm +
25	25,5 mm	50 mm	35,4 mm +
22	29 mm	58 mm	41 mm +

- **Timing of release and placement of refuge: It is recommended that the refuges are drawn towards the edge of the pen where the fish are to be released so that the fish only have a short distance to the refuges where they can attach themselves and calm down.**
  There is no definite data on this, but one hypothesis is that lumpfish that do not quickly find a place to settle down on while it is stressed after transportation, need more time to calm down and are more vulnerable to chronic stress and mortalities. If there are strong sea currents at the farm site, it can pay to release the fish to go with the direction of the current so they are not pressed against the net wall, forcing them to have to swim against the current in order to reach the refuges.

Attachments:

Attachment 1: Diverse regulations

Regulation of the transport of aquaculture animals (translation):
http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf

The Aquaculture Operation Regulations (translation):
http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf

The Animal Welfare Act (translation): https://www.regjeringen.no/en/dokumenter/animal-welfare-act/id571188/ **Diverse provisions, regulations, advice and guidance from the Norwegian Directorate of Fisheries** (NDF) (http://www.fiskeridir.no/) or the Norwegian Food Safety Authority (NFSA) (http://www.mattilsynet.no/)

Attachment 2: Water quality

The summary on water quality is an excerpt from Rosten m.fl. (2004 and 2007), Stefansson m.fl. (2015) and Terjesen m.fl. (2013). See reference list for literature.

Temperature:

With high temperatures, the fish will encounter problems with meeting oxygen requirements due to heavily concentrated consumption and reduced oxygen content in the water, and the fish also have problems with osmoregulation (water balance). Low winter temperatures have seemingly fewer consequences for welfare; there is a lower limit nonetheless. Problems with osmoregulation also occur with low temperatures.

Oxygen:

Oxygen content in water (measured as milligram oxygen per litre in water) with 100 % saturation generally tapers off with an increase in temperature and salinity. The fish's oxygen consumption increases with rising temperature, activity and feed consumption, and small fish have relatively higher oxygen consumption (mg O_2 per kg fish) than large fish. Dissolved oxygen is essential for the fishes' respiration and is normally expressed in mg per litre water or in the percentage of saturation. Over a critical concentration, consumption is not dependent on concentration. Below the critical level, oxygen consumption is reduced with diminishing concentration.

The oxygen diffuses into the blood over the gills due to the difference in partial pressure between water and blood and is bound to the haemoglobin molecules in the red blood cells. The oxygen is released again from the haemoglobin when CO_2 from metabolism is released from the cell and produces reduced pH in the blood (Bohr and Root effect). In turn, due to differences in partial pressure, oxygen will diffuse into the cells and CO_2 will exit. In contrast to humans, it is the oxygen content in the blood and not CO_2 content that governs the rate of respiration. With oxygenation and oversaturation of water with oxygen this can lead to a reduction in the rate of respiration to a level that is too low to the enable the fish to transport CO_2 out of its blood over the gills and subsequently hypercapnia occurs that reduces the blood's capability of transporting oxygen, but the blood's oxygen content also sinks and the urge to breathe is stimulated again.

Rapid anaerobic swimming increases lactic acid content in the blood and reduces pH, which also reduces the blood's capacity for oxygen intake. With continual anaerobic swimming, the amount of lactic acid may exceed the blood's buffer capacity and acidosis occurs with an ensuing collapse of the fishes' oxygen transport. Under stress, hormonal changes also occur that result in an enhanced capacity for oxygen transport in the form of a higher ventilation rate, greater oxygen flux over gills, and improved intake in the blood cells (reduced Bohr effect). In salt water, the fish will leak water over its gills and consequently encounter problems with water and ion balance. Late mortalities occurring among salmon a few days after a fish stock transport are largely due to this phenomenon.

Carbon dioxide (CO_2):

CO_2 is in the same way as ammonia a waste product (metabolite) of metabolism that is directly linked to oxygen consumption, in an approximate ratio of 1:1 between consumption of O_2 and secretion of CO_2. CO_2 can act as a negative for the fish's welfare and high values will lead to reduced growth, disorders in acid base and ionic regulation, and kidney injuries and reduced oxygen binding capacity of haemoglobin. CO_2 toxicity is assumed to be greater with lower oxygen saturation and salmonids

appear to be more sensitive toward CO_2 at low temperatures rather than high. CO_2 content must amount to over 30-40 mg CO_2 per litre before one can produce evidence of the acute effects of an excessively high level of CO_2. Recommended limit values for CO_2 generally lie in the region of 20 mg/l to 10 mg/l. There is reason to believe that tolerance of CO_2 is dependent on other water quality. The Norwegian Food Safety Authority recommends maximum 15 mg /l carbon dioxide under production conditions (chronic levels*).* The solubility of CO_2 is reduced by rising temperature and salinity. The higher the temperature, the easier it is to aerate CO_2.

pH: Simply put, pH is primarily governed by the secretion of CO_2 where pH drops with increasing CO_2 concentration (that is in balance with carbonic acid). Aeration of transport water contributes therefore to controlling and stabilising pH under fish transportation. Toxicity of TAN increases in tandem with an increase of pH (a larger proportion of TAN exists as NH_3).

Ammonia (TAN):

Ammonia (TAN: total ammonia) is, in likeness with CO_2, a waste product (metabolite) of metabolism that has a direct connection to oxygen consumption. Rule of thumb: you can apply the ratio 10:1 between consumption of O_2 and production of TAN. Checks of oxygen consumption provide a useful indication of the amount of accumulated ammonia.
Un-ionised ammonia (NH3) is the most toxic form of ammonia in fish and the proportion of un-ionised ammonia increases with an increase in the level of pH. High concentrations of NH_3 are harmful to the central nervous system, amino acid metabolism, disorders in enzyme systems, and result in gill damage and osmoregulatory disturbances. The maximum recommended level of un-ionised ammonia (NH3-N) for salmonids in different environments is normally on a scale of 12 µg -25 µg/l.

References

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Industry guidelines – sea lice

Subject:	Best practice guidelines:
Cleaner fish	**Use and husbandry of lumpfish**

Prepared by:	Contact person:	Date:	23.02.2017
FHF cleaner fish project	Eirik Sigstadstø, FHF	Page:	**Page 54 of 62**

Objective:

This guideline offers information and recommendations that contribute toward achieving optimum and efficient use of lumpfish as cleaner fish in combating the sea lice problem, meanwhile safeguarding the lumpfishes' welfare and health.

Special conditions:

The lumpfish is different from other wrasse fish in many ways, including that it has a suction cup on its belly that it uses to attach itself to different surfaces. As lumpfish are increasingly being used as cleaner fish, the more knowledge and experience will be gained about this species by the industry. Keep an eye out for events such as cleaner fish conferences, cleaner fish courses and seminars for the latest information.

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25. Preparations:

General:

Employment of lumpfish needs to be planned well in advance. Planning should be based on geographical considerations and anticipated risk of infection. This varies from south to north along the Norwegian coastline, and an optimum strategy is for example probably quite different for Western Norway from Finnmark County in the northernmost reaches of Norway.

A visit is recommended to the juvenile producer to gain a basic understanding of the lumpfish's needs and how measures in salmon pens can be carried out to achieve a good result. Ensure proper quality assurance and follow-up of the fish. See attachment for checkpoints on quality assurance and follow-up.

Measuring instruments and other equipment that the lumpfish can attach itself to must be covered to prevent errors in measurements and/or injury to the fish.

Ensure that the correct equipment is available before delivery of the fish.

- Refuges
- Feeding stations
- Oxygen, salinity and temperature gauge
- Hand net with fine netting and without knots (smolt linen). Dip nets are not suitable.

For information about transport, unloading, delivery inspection and carriage out to installation, see separate guideline on the transport of lumpfish.

Familiarise yourself with the current regulations:

Description

There are no specific regulations on cleaner fish. Cleaner fish are legally considered aquaculture animals from the time they are captured. The Norwegian Food Safety Authority regulates farming, welfare and use of cleaner fish according to the same regulations that apply to the care of fish farmed for human consumption.

Norwegian Food Safety Authority (NFSA); on cleaner fish with reference to current acts and regulations:
http://www.mattilsynet.no/fisk_og_akvakultur/akvakultur/cleaner fish/
(N.B.: On the NFSA website, click on 'Language' for English)

Nets

The shape of the lumpfish varies and width/height are more decisive factors than the length in determining if it can pass through the net or not.

Photo: Kvarøy Fiskeoppdrett

The size of the openings in the net will vary depending on supplier, whether it has knots, whether it is impregnated, and with different grades of handling. Lumpfish are vaccinated according to the recommended smallest size 8-10g and are released after the recommended 500 degree days from vaccination. The smallest size for the lumpfish will then be around 30 g, but there can be variation down to 18-20g. The table below is a guideline only as sizes will vary.

Scope	Half-mesh	Whole mesh	Lumpfish (width/height)	Lumpfish
40	15.5 mm	27.5 mm	21.9mm/17.5 mm	6.2 gram
38	16.5 mm	33 mm	23.3 mm/18.6 mm	7 gram
35	18 mm	36 mm	25.5 mm/20.2 mm	8.2 gram
32	20 mm	35 mm	27.6 mm/21.7 mm	9.4 gram
30	21 mm	38 mm	29.7 mm/22.8 mm	13 gram
28	22.5 mm	40 mm	31.1 mm/23.3 mm	15 gram
25	25.5 mm	42 mm	34.5 mm/24.9 mm	24 gram
22	29 mm	50 mm	41 mm/27 mm	

Table prepared by Marine Harvest Midt

Refuges

Lumpfish live the first part of their lives in a kelp forest, and are to a large degree pelagic the first years before they leave the strand zone and migrate further out in the sea to search for grazing grounds. Juvenile lumpfish have no

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swim bladders, and in the kelp forest use their 'inbuilt' suction cups to attach themselves on smooth surfaces, often in a refuge in shade, probably for rest and as a natural protection mechanism.

Plan for refuges to function as cleaning stations; a place where the salmon go to be relieved of lice. Good refuges and adequate surface area are vital in reducing stress and ensuring good fish welfare. Producers have found that lumpfish prefer shade and smooth, rigid surfaces to attach themselves to (by suction) in the pen. Kelp forests are serviceable for both large and small lumpfish, but the larger lumpfish (60g+) often prefer settling on rigid surfaces. One way of creating shade is to have horizontal kelp ribbons the length of the curtained area on the (water's) surface. Tail nipping and aggression may prove a challenge, but planning that provides sufficient space for refuges and use of feeding stations in refuges will reduce this problem.

Several types of refuge are available on the market, such as ring refuges, curtain refuges and rigid refuges. Most producers have found curtain refuges work well as cleansing stations, where it is vital to have enough space between the curtain refuges to allow the salmon to swim between the refuges. One way to increase space for refuges is to increase kelp ribbon density, instead of increasing the number of curtain refuges. Pipe refuges are not recommended, as these do not allow the salmon the opportunity to swim into the refuge for delousing.

Illustration of ring refuge on left and curtain refuge to the right.

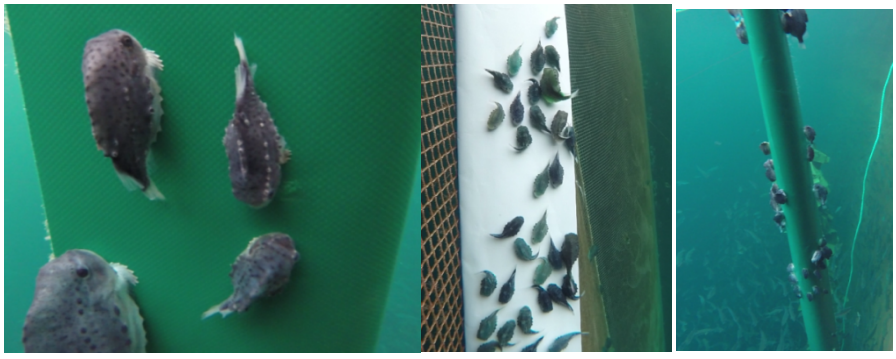

Photo of lumpfish on rigid refuge. Photo: ProAqua AS

Description

Kelp curtain tunnel: lumpfish in refuge, salmon passing by. Photo: NorseAqua

Recommended refuge ribbon quantity:
The length and number of refuges/resting spots are dependent on the number of salmon and mix percentage. As a reference point producers experienced in lumpfish husbandry and use of refuges recommend that the quantity of kelp ribbon should be enough to cover requirements for refuges/resting spots for 50 lumpfish.

Example:
Calculation of refuge:
Number of salmon: 90 000
Number % cleaner fish: 7% (6300 cleaner fish)

Refuge requirement: 126 meter

Consideration should also be given to the fact that different suppliers deliver different sizes/volumes of kelp. Contact suppliers for further recommendations and advice.

Placement of the refuges:
Refuges must be positioned before lumpfish are released into the pen. Take into account the direction of the sea current and feeding point for the salmon in relation to the placement of refuges and monitor with the camera where lumpfish are most comfortable and make appropriate adjustments.
Avoid placing refuges alongside the net wall, by salmon feeding stations, resting close to the bottom of the net in a cone-shaped net or in the middle of the net.

Proportion of lumpfish to other cleaner fish:
There is no specific recommendation on blend percentage and the mix of fish can vary from 2 - 15 %. Keep a firm focus on fish health, fish welfare and practising optimum lumpfish husbandry to extend the life expectancy of the lumpfish that are released.
Lumpfish are known to be less active than wrasse in the high temperatures of summer, so an increase in the proportion of lumpfish in the course of summer as a measure against added pressure of possible infection from sea lice should be considered in relation to the anticipated effect and history of lumpfish suffering a high mortality rate with high sea temperatures.
Due to the risk of infectious diseases, it is recommended to not release lumpfish in pens with lumpfish of other origin or a group lumpfish that has a number of/many mortalities.

26. Implementation:

Description

Lumpfish husbandry

Cleaner fish are defined as aquaculture animals and the Norwegian Food Safety Authority exacts the same requirements of husbandry, fish welfare and disease control as for salmon. Slaughtering shall take place under the same conditions as for salmon, and lumpfish are killed by anaesthetisation in a bath as and when this is required.

Cleaning of net and refuge:

Cleaning of nets and refuges must be planned and carried out every 7-14 days in summer, depending on environmental conditions and temperature at the installation site. There is less fouling of nets and refuges in winter, and routines must be adjusted accordingly.

Immediately after release, there should be a plan to allocate at least a week to the first post-release net and refuge wash so that lumpfish get the chance to settle in the refuges. In practice, this can be difficult to achieve in summer with a lot of fouling on the nets, but producers report that washing nets and refuges a few days after the release of fish works well. Good routines for drying/washing of refuges must be planned so that fouling growth is unable to build up. Make sure that refuges are moved in toward the centre of the net before washing so that lumpfish do not fall outside the net when the refuges are lifted up from the water for cleaning. One alternative for drying refuges is the use of refuge cleaners that are now available on the market. Net washes can be carried out either by marine farm workers or hire of machinery, crew and vessel through a company providing these services.

Make sure cleaning is scheduled for the dead fish net, feeding equipment, ropes, camera and other equipment/devices positioned in the pen.

Lift-up and dead fish net:

- No reports have been received of any major problems with lumpfish in the dead fish net. Lumpfish have - in contrast to wrasse and salmon - no swim bladder. Nonetheless, an effort should be made to dissuade the lumpfish from attaching themselves to the dead fish net, in that swift handling of the net will also cause the for lumpfish considerable stress, particularly with low air temperatures.
- When registering dead fish, consideration must be given to make sure not all fish end up in the dead fish net.
- Use of a lift-up system works well with regard to management of lumpfish, but it has been observed that some lumpfish remain in the hose and most likely die through a lack of oxygen. Use the stocking at the entrance to the lift-up to create a little movement in this to frighten off any lumpfish that might find itself in the entrance.
- Injured lumpfish shall as with salmon be killed after anaesthetising and then converted into fish silage. With anaesthetising of lumpfish, it is favourable to consider giving more than double the anaesthetic dose that is normally used for salmon.

Feeding

Lumpfish only eat food that is in motion and thus soft feed in stockings or similar is not recommended. Insufficient feed available will result in lumpfish congregating alongside the net wall and grazing on the different organisms on the nets.

Feeding should be carried out so that as many lumpfish as possible have access to feed. Calculate the correct amount of feed (Example: for 2 % feeding to 17,000 lumpfish weighing on average 30g requires 10.2 kg feed). Execute feeding in the refuge area and from separate feeding automats. Several types of automats are available on the market. Feed manufacturers (Biomar, Skretting, and EWOS) offer small pellets specially designed for lumpfish feed.

The following is recommended by the feed manufacturers:
After release into pen: 2-3 % daily feeding of biomass, daily up to 6 weeks.
Summer: 2-3 % daily feeding of biomass, 5 days per week.
Winter (<6C): 1.5 % daily feeding of biomass, 5 days per week. Feeding in even doses during the day.

Some producers feed the lumpfish for 2-4 hours and finish the meal before the salmon have finished their feeding. It takes time to gather the lumpfish together, and the aim is to have the lumpfish ready in the refuges to go to work cleaning the salmon after the salmon have finished eating their meal.

Description

Finnmark producers have reported that the ratio for daily feeding routines is maximum 2% with a sea temperature over 10˚C and maximum 1% in winter. If feeding is skipped for a day or two, the lumpfish will seek alternative food such as fouling growth, salmon feed or nip at sores and fins. It is recommended to hand feed a small amount during the work day to make an observation/assessment of the lumpfish. Healthy fish will quickly react and capture the feed, and other fish that are sick or stressed will be slower to react.

Assessment of effect

This is carried out on the basis of the installation's lice figures, historical lice figures, zone count and checking of lumpfish stomach content from autopsies. Use a camera to ascertain the time of day (24 hours) when the lumpfish eat, catch lumpfish for autopsy immediately after active grazing behaviour has ended. The lumpfish must be anaesthetised and killed for checks of stomach content.

- Sea lice have been detected in a lumpfish's stomach after autopsy at least 6 hours after the fish has grazed on lice at temperatures of 15 °C (lab experiment). Lumpfish graze periodically in intervals, and in these periods are extremely active, swimming forcefully around in the water on the hunt for food.
- The easiest and most delicate way to examine stomach content is to remove the stomach content, loosen this in water and study against a white background (after killing and autopsy). Due to considerable differences in feed preferences among certain individuals, it is recommended to take out at least 15 fish per pen for the purpose of autopsy.

Essential considerations:

- Low lice figures hamper detection of lice in lumpfish stomachs.
- Lumpfish appear to be particularly active during the day. 11am to 12 midday appears to be the best time as inspections carried out then have provided good results.
- Location in pen for catching lumpfish: Typically it would appear the weakest fish are found beside the net (with clean nets), while robust fish stay in the refuges. It is important that it is not just the fish that are easily caught along the edge that are examined, as it is less likely that they are eating lice.
- If stomach content consists largely of diverse crustaceans, it can be a sign that the net must be flushed and/or that the refuges must be cleaned.
- Lumpfish will probably prefer big lice. Assessment of the effect should therefore mainly focus on the number of mobile and in particular adult female lice.

Photo 1: shows an opened stomach and stomach content as a clump. Photo 2 shows the same stomach content loosely in water on a white background. Photo 3 is an example of lice found in the stomachs of lumpfish.

Welfare/health inspections

Health inspections of lumpfish are regulated in the legislation, and it is most beneficial if inspections are carried out with routine visits. The fish health service should be contacted if there is an increase in mortalities ($\geq$ 2 % the first 6-8 weeks, thereafter $\geq$ 1 %). Screening with transport and release is vital to reducing the potential for cleaner fish becoming a vector for disease.

Common symptoms of disease or diminished health are emaciation, sores and wear-and-tear injuries to skin, cataracts or suction cup deformities. Erosion and tail rot are also common, in some instances also seen together with tenacibaculum or vibrio infections.

- The lumpfish is a total newcomer to the marine farming industry. Data about disease and health concerns is in short supply as yet. It is important that samples are taken frequently with mortalities; both histological

Description

and bacteria samples to document key pathogens. Take note that with a result (withdrawal) of 96% ethanol, this indicates suspicion of parasites (eyes, brain, gills). Also check belly for parasites.

- Lumpfish need effective vaccines that are readily available. To enable further development of vaccines it is important that health personnel are active in following up the fishes' progress.
- Tail wear-and-tear/tenacibaculum infections have been a widespread problem that should be mentioned with all fish health visits.
- Weight and length should be measured with each visit to determine rate of growth and to calculate the right amount of feed to be given to the fish.

For disease descriptions, methods for taking of samples and essential equipment, refer to the Norwegian Veterinary Institute or other organisations/enterprises that offer diagnostic services.

Handling of lumpfish before/during delousing

Pay attention to the lumpfish during delousing. The primary concern should be to keep the lumpfish away from delousing equipment that is engaged in livestock crowding prevention, pumping and handling of fish. Some producers move refuges to the opposite end of the pen from where the delousing equipment is located. Most of the lumpfish stay in the refuges, away from cast nets and after the weighted dragnet has passed under the refuges. Nonetheless, watch out for lumpfish that have been caught up in the net and end up in the well boat/delousing equipment. These must be retrieved and handled as gently as possible. Check that equipment designed to protect cleaner fish during delousing operations is functioning correctly.

Photograph of the salmon farm pen during delousing procedure, where refuges are being moved to the opposite side away from where the wellboat is anchored. Large numbers of lumpfish are observed in the refuges where they are safe from being caught up in the handling and pumping part of the delousing process.

Termination (sorting, relocating, slaughtering or other situations):

Retrieval of fish may be necessary if the lumpfish cannot be used any longer in the same pen/installation, e.g. prior to sorting, slaughtering etc. The challenge lies in accomplishing the retrieval of fish as there is no information available on good methods for this. When the farm site is laid fallow, the lumpfish must be taken out of the pen(s). Further use of lumpfish at another facility/installation is permitted, but consideration must be given to the risk of infection in a transfer after any quarantine period. Lumpfish cannot be moved in or out of areas with restrictions. Moving must be risk-assessed by the individual enterprise and normal regulations for moving of fish livestock also apply to lumpfish.

Sorting: Lumpfish are sorted out together with rejects, and slaughtered following anaesthetisation and destroyed. Alternatively, they can be sorted out together with the sorting of small fish and put to further use. If planning the further use of the lumpfish, it can be relatively easily retrieved with the aid of a hand net when the weighted net is being dragged.

Description
27. Registration:
• Delivery inspection • Mortalities and blend percentage • Effect assessments • Health inspection • Termination of cleaner fish usage
28. Deviation management:
• Report back to fisher/supplier in event of mortalities after delivery, and request compensation if mortalities exceed agreed levels. • Other common methods of deviation management if deviation(s) should occur.

Safeguarding against escapes:

- Good routines for delivery of cleaner fish.
- Use minimum size measurement for livestock. The nets must have the correct mesh width.
- Use refuges that are not at risk of rubbing abrasively on the net.
- Good routines for release and retrieval of refuges.

References:

- The Aquaculture Operation Regulations (translation): http://www.fao.org/fileadmin/user_upload/animalwelfare/English.aquaculture.operation.regulation.2008.08.01._final.pdf
- The Animal Welfare Act (translation)**:** https://www.regjeringen.no/en/dokumenter/animal-welfare-act/id571188/
- Diverse provisions, regulations, advice and guidance from the Norwegian Directorate of Fisheries (NDF) (http://www.fiskeridir.no/) or the Norwegian Food Safety Authority (NFSA) (http://www.mattilsynet.no/)

Information available at www.lusedata.no :

- Example of a contract between buyer and fisher of wrasse/cleaner fish
- Example of delivery form in Word
- Example of delivery form in Excel

Attachments:

Suggestions for checkpoints in quality assurance/lumpfish log entries:

Delivery inspection

- Health and origin certificate shall be on hand for inspection with delivery.
- Open up 10 lumpfish to check if there is vaccine residue in their bellies. There should not be any free-floating vaccine in the belly.

Note the following for vaccination of lumpfish at the delivery site:

- Which vaccine product
- Size of fish at time of vaccination
- Average weight and degree days after vaccination

Note the following for transport:

- Note any deviations that have occurred under transport
- carrier
- information about secondary transport

Pen livestock follow-up:

- Note which pen that individual fish group have been released into
- Number of lumpfish
- Mortalities
- Weight follow-up – decisive for accurate calculation of feed distribution
- (amount of feed) per pen