Bivalve Shellfish Purification Operations

A Seafish / REHIS Joint Award

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Date

Here to give the UK seafood sector **the support it needs to thrive.**

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Who Seafish are and what they do

- Set up by the Fisheries Act in 1981 and their sponsor is the Department for Environment, Food and Rural Affairs (Defra).
- Most of their funding comes from a levy on the first sale of seafood products in the UK and this includes imported seafood.
- The Seafish Board is responsible for the strategic direction.
- The only pan-industry body in the UK offering services to all parts of the seafood industry.
- Seafish is here to give the UK seafood sector the support it needs to thrive. In their Corporate Plan 2023 to 2028, there are seven key areas including: Ensuring a Safe and Skilled Workforce.

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Bivalve shellfish purification

- Aim - To provide the information you need to:

  - **Understand** the complex requirements necessary to ensure successful purification operations.
  - Ensure **food safety** is prioritised.
  - Achieve a satisfactory result in the **exam** that will follow this course.

Bivalve Purification Operations programme

Course Module	Duration (Mins)
Introduction	20
Threats to Human Health	70
Legislation	30
Environmental Requirements of Bivalve Shellfish	45
Risk Management & Record Keeping	30
Depuration Tank Design, Operation and Bivalve Shellfish Handling	60

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Introduction

Introduction

- What is bivalve shellfish purification?
- What species are purified?
- When do we need to use it?
- What does purification involve?

Seafish guidance: Bivalve shellfish purification webpage

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What is depuration/purification?

- The use of a ***controlled***, aquatic environment to reduce low-level contamination by ***bacteria*** and viruses in live bivalve shellfish (to a safe, acceptable level for human consumption).

- A ***natural*** biological process to ***purge pollutants*** from bivalve shellfish, ***managed*** at a plant.

- **NB:** Relaying bivalve shellfish is a process used exclusively for the natural purification of live bivalve shellfish, the areas used are classified areas of sea, estuaries or lagoons with clearly marked boundaries indicated by buoys, posts or any other fixed means.

– ***only the time period and location are actively managed!***

Bivalve shellfish

- Pacific oyster (*Crassostrea gigas*).
- Native oyster (*Ostrea edulis*).
- Mussels (*Mytilus sp.*).
- Razor clams (*Ensis sp.*).
- Cockles (*Cardium edule*).

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When do we use purification?

- **A** Class Waters: minimum of 10 samples per year, 80% of sample results must be less than or equal to 230 *E. coli*/100g, no results may exceed 700 *E. coli*/100g.
    - Under current legislation ***no purification needed*** but consider best practice!

- **B & B-LTC** Class Waters: 230 to 4,600 *E. coli*/100g:
    - Relay/***purify***/heat treat.

- **C** Class Waters: 4,600 to 46,000 *E. coli*/100g flesh
    - Long-term relay / heat treat.

- **Prohibited areas**: more than 46,000 *E. coli*/100g flesh

Seafish guidance: Classification of bivalve harvesting and production areas webpage.

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Long Term Classification (LTC)

- A longer-term classification for Class B compliant bivalve shellfish beds.

- **Benefits:**

    - Demonstrates greater stability in an area – potentially increases saleability.

    - Based on compliance over five years – ‘smoothing’ the effect of poor results.

    - The same protocol is followed for LTC beds as annual Class B, the only difference occurs when analysing compliance levels whereby five years data is analysed as opposed to three years for Annual Classifications.

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Local Action Groups (LAG) and Plans (LAP)

- **LAG -** Set up to assist LEAs in the investigation of high *E. coli* and positive Biotoxin results. Membership includes LEA, FSA, CEFAS, EA, water companies, IFCA and sometimes local FBOs.

- **Primary function -** Act as a conduit for effective exchange, contribute relevant data and inform decision on appropriate health protection measures.

- **LAP** - LAG is responsible for developing a LAP that includes:
  - Exceedance levels for *E. coli* and Biotoxins
  - Process for investigation and
  - Action State investigations *

***NB Investigative State** = Class B and Class B-LTC.

Action State = Applies to all classifications.

Dealing with high results

Local action groups exist in England and Wales.

A local action group is led by your local authority and can include local industry groups, fishermen or shellfish gatherers and other stakeholders who can contribute to the investigation, e.g. the Environment Agency or Natural Resources Wales and Water Companies.

This group deal with high results and consider whether to:

- close the bed
- notify harvesters
- take action to protect public health
- liaise with FSA food incidents when necessary

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What does purification involve?

- Species
- Biomass
- Water flow rate
- Clean water - UV/Ozone/Hybrid systems
- Time (42 hours ***or less if approved by Local Authority***)
- Temperature / Salinity / Dissolved oxygen
- Use of purpose designed equipment
- Permanent Management Procedures (Risk Assessment) – HACCP

Why is purification needed?

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Threats to human health

What are the threats to human health?

- Group to list these.

Biological threats to human health?

- Bacteria.
- Viruses.
- Algal toxins.

Bacteria

What are bacteria?

- Small size (0.2 to 4 micrometres)
- Many types, shapes and forms
- Independent living organisms
- Can multiply rapidly
- Some species, such as Vibrio, have been implicated in producing toxins such as Tetrodotoxin (TTX)

See the Eurosurveillance website for further information.

Significant bacterial pathogens in bivalve shellfish

- Salmonella species – 12%*:
  - serious illness for months
- Other bacteria include:
  - *Clostridium perfringens*
  - Bacillus species
  - Campylobacter species
  - *Staphylococcus aureus*.

- The increased prevalence of Vibrio species and the first reporting of *Vibrio jasicida* and *Vibrio rotiferianus* at UK shellfish sites.

- See this Science Direct webpage for further information.

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Monitoring: role of bacteria as indicators

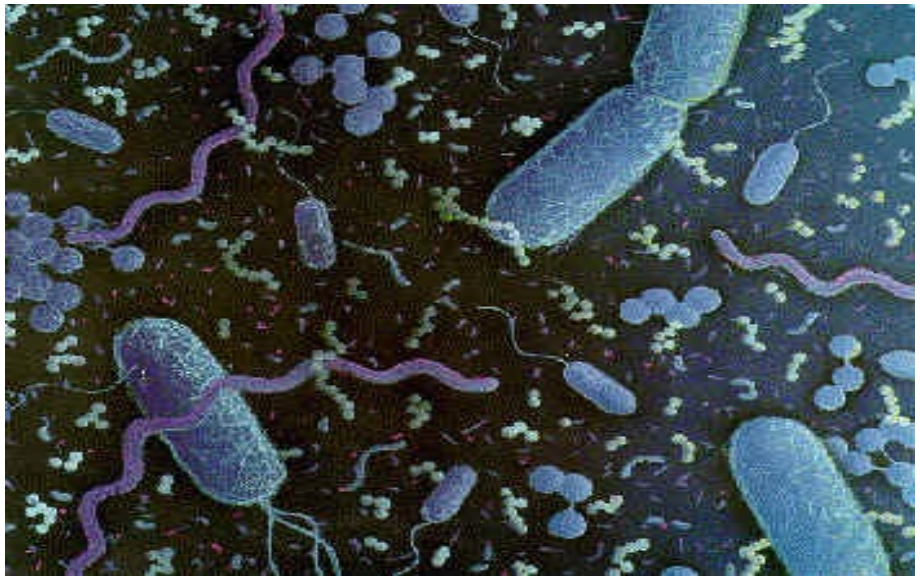
- ***E. coli*** used as an indicator of gross faecal contamination (*Note: relationship with Norovirus covered later*).

- **Measuring *E. coli* levels:**

- Easy to measure.

- EHOs and Regulators monitor levels.

- Food Business Operators (you) should monitor by:
  - End product testing



Note: Impedance and Pour Plate are now recognised as an alternative to MPN in enumerating *E. coli* levels.

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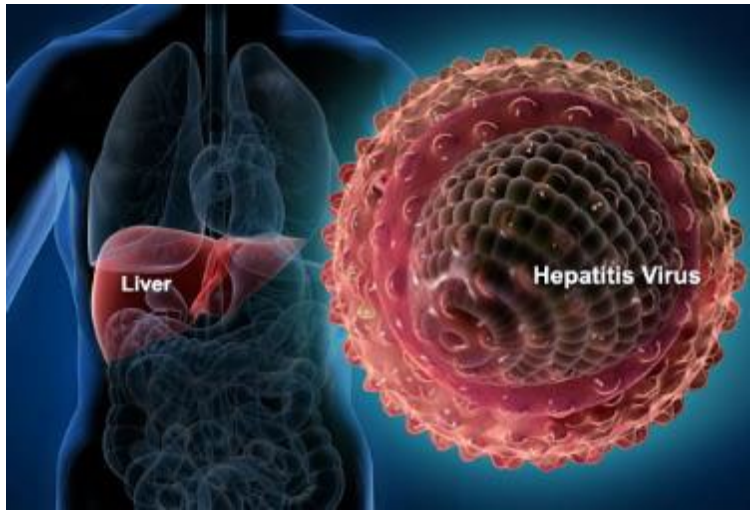
Viruses

What are viruses?

- Very small entities (10 - 200 millimicrons)
- Alive?
- Highly specific
- Very low infective dose
- Possible to identify and quantify
- Difficult to assess level of risk
- Source of contamination is normally sewage
- **Main source** of bivalve shellfish related food poisoning cases!
- Current depuration times are **not** long enough to remove viruses.

Significant viral pathogens

- Norovirus - severe gastroenteritis
- Seafish guidance on Oysters and Norovirus webpage.
- Hepatitis - serious illness



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Sewage!

- Sewage contaminated filter-feeding bivalve shellfish (oysters, mussels, clams) are recognised vectors of food poisoning.

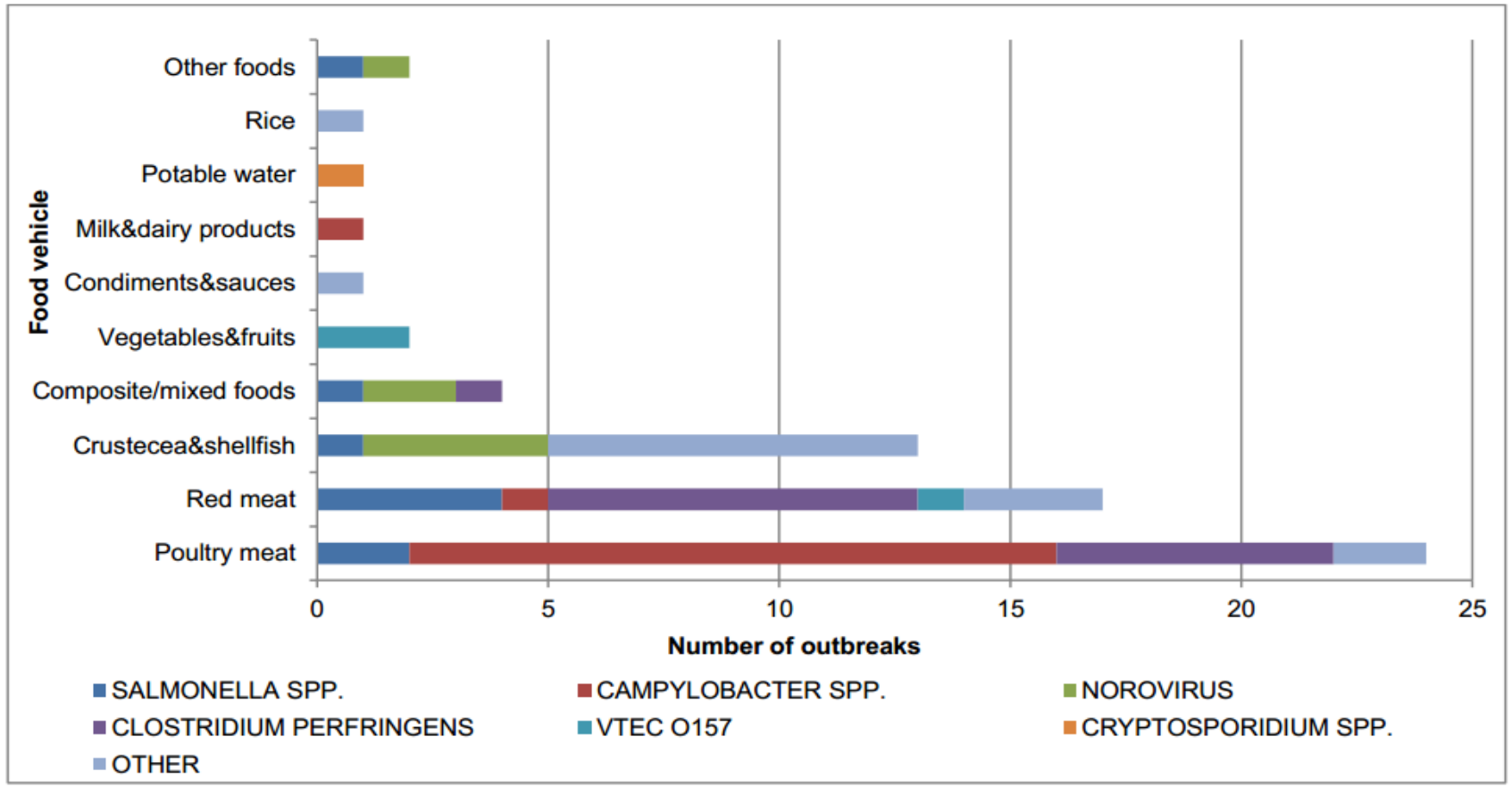
- Water companies are actively working with industry to mitigate the impact of significant pollution events.

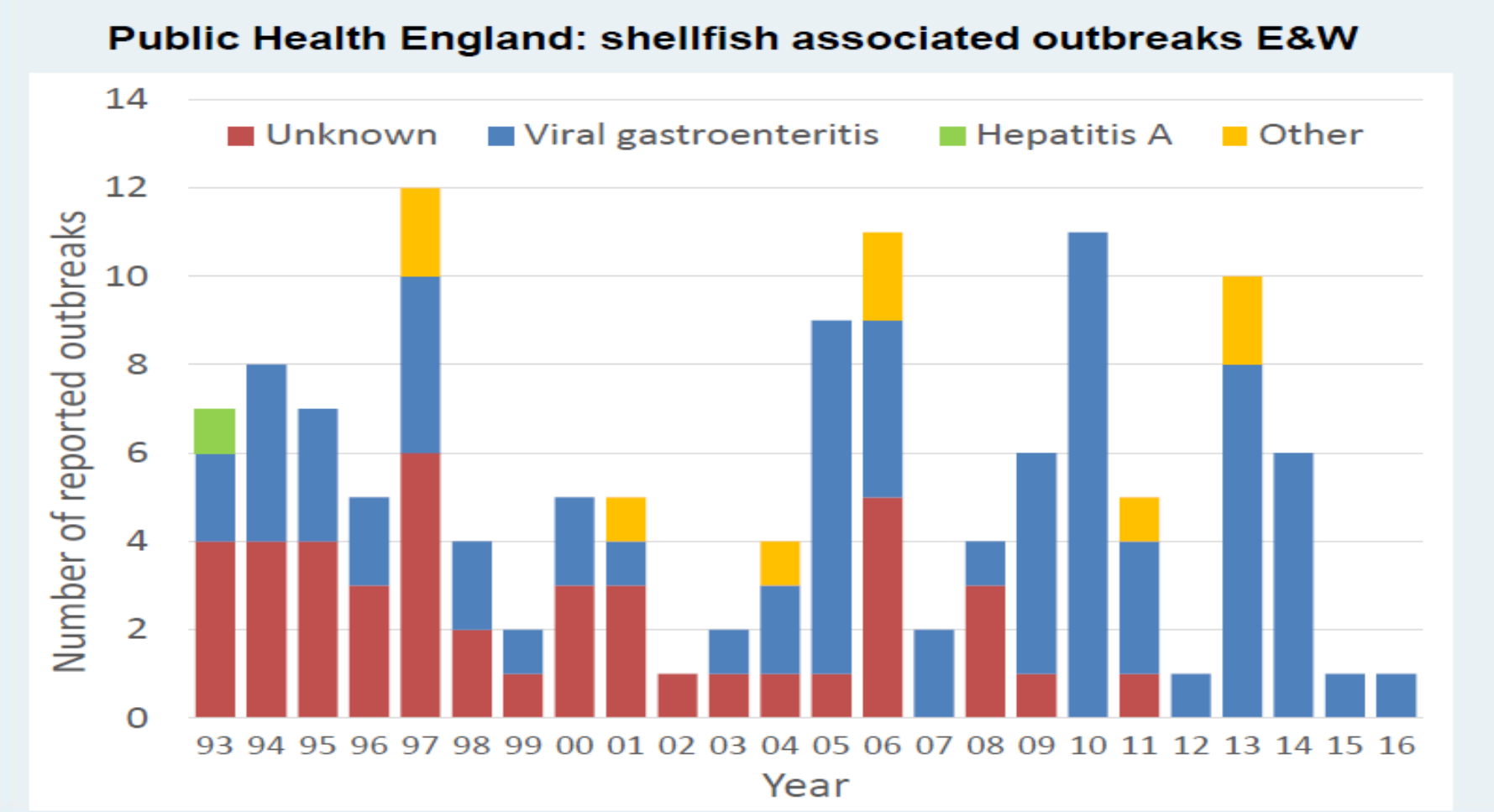
- Water companies are not the only source of sewage contamination e.g. leaking septic tanks, diffuse pollution.

Outbreaks in England and Wales

PHE Gastrointestinal Infections Data

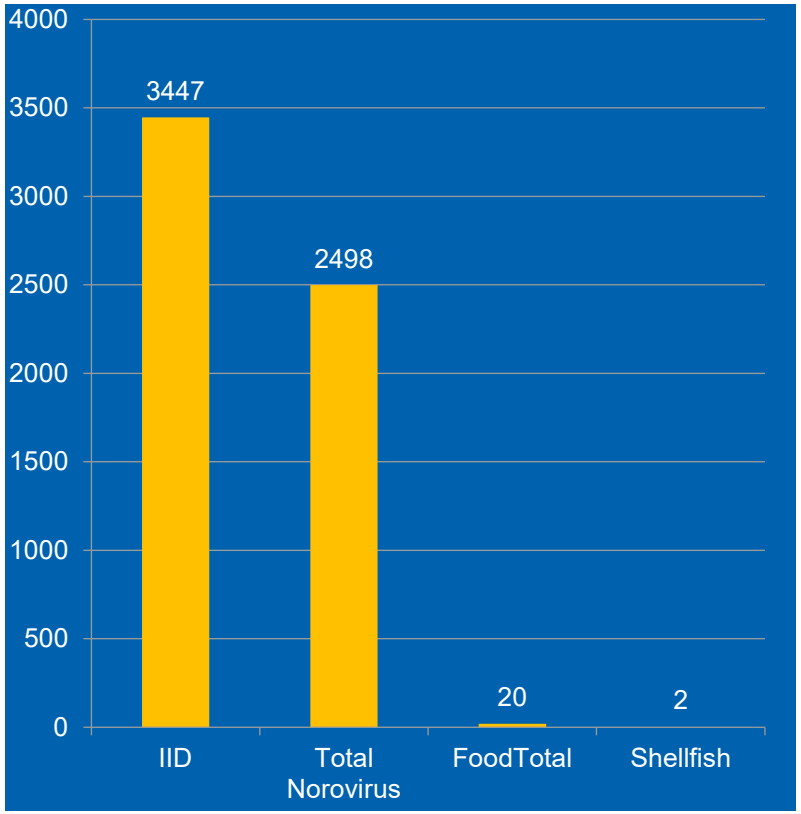
Summary of eFOSS *data*, 2013




Public Health England: shellfish associated outbreaks E&W
Unknown
Viral gastroenteritis
Hepatitis A
Other
Number of reported outbreaks
0
2
4
6
8
10
12
14
93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16
Year

Food Poisoning Statistics

- Total Infectious Intestinal Disease (IID) outbreaks in Scotland 1996 to 2011 – Health Protection Scotland.



- Almost 3500 in total in the period
- Almost 2500 caused by Norovirus
- Almost 2500 NOT caused by food
- 20 caused by food
- 2 caused by bivalve shellfish
- Why do people always blame the bivalve shellfish?

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E. coli and Norovirus

- There is no permanent relationship between the levels of *E. coli* and Norovirus:
    - although there appears to be a **site specific** relationship.
    - Food poisoning outbreaks from viruses have occurred even when *E. coli* levels were very low.
    - The absence of *E. coli* does not guarantee low viral levels.
- They have different behaviours in the sea and in bivalve shellfish e.g. length of viability and potential for binding within bivalve shellfish (see next slide for comparison).

Comparison of reduction rates during depuration – Pacific Oysters

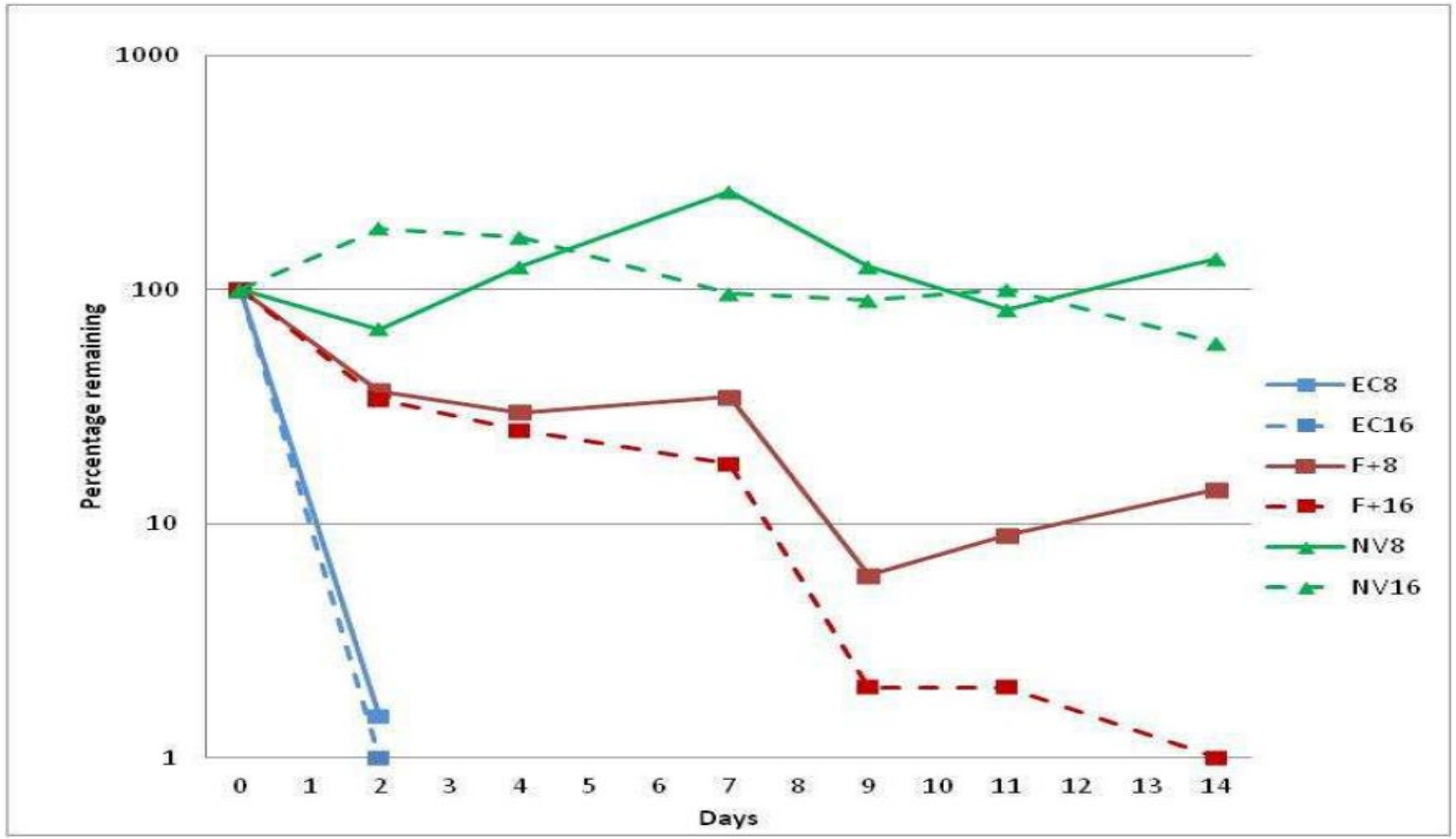


Figure 7. Comparison of *E.coli,* FRNA bacteriophage and norovirus reductions during depuration. Depuration conducted at 8°C (solid line) and 16°C (dashed line). EC = *E. coli*, F+ FRNA Bacteriophage, NV = norovirus. (Each data point calculated from the geometric mean of four replicates).

Algal toxins

What are phytoplankton?

- Microscopic free-floating algae
- Photosynthetic
- Form large blooms
- Ingestion may be toxic
- Becoming more common?
- Seafish guidance on Marine Biotoxins webpage.

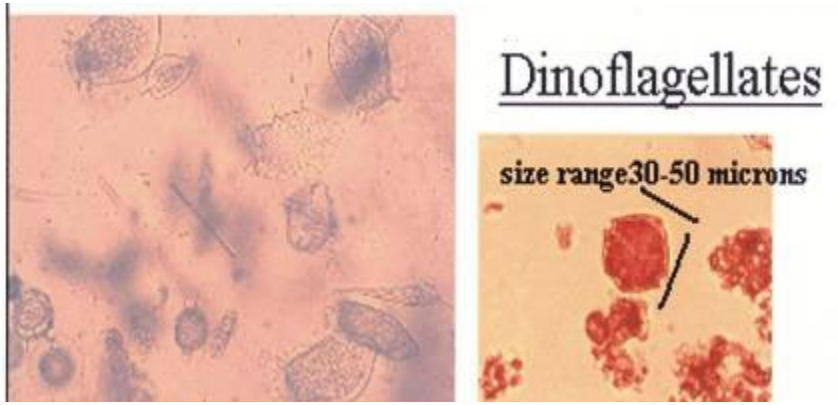
Harmful Algal Blooms (HABs)

- Phytoplankton – Dinoflagellates and Diatoms.

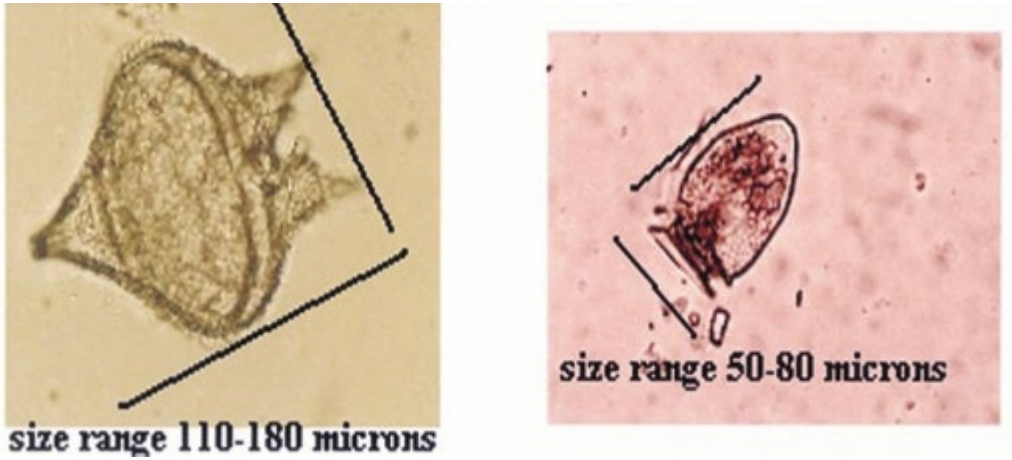
- HABs and Biotoxins:
  - DSP - **Diarrhetic**
  - PSP - **Paralytic**
  - ASP - **Amnesic**

ASP = Pseudo-nitzschia

PSP = Alexandrium



DSP = Dinophysis



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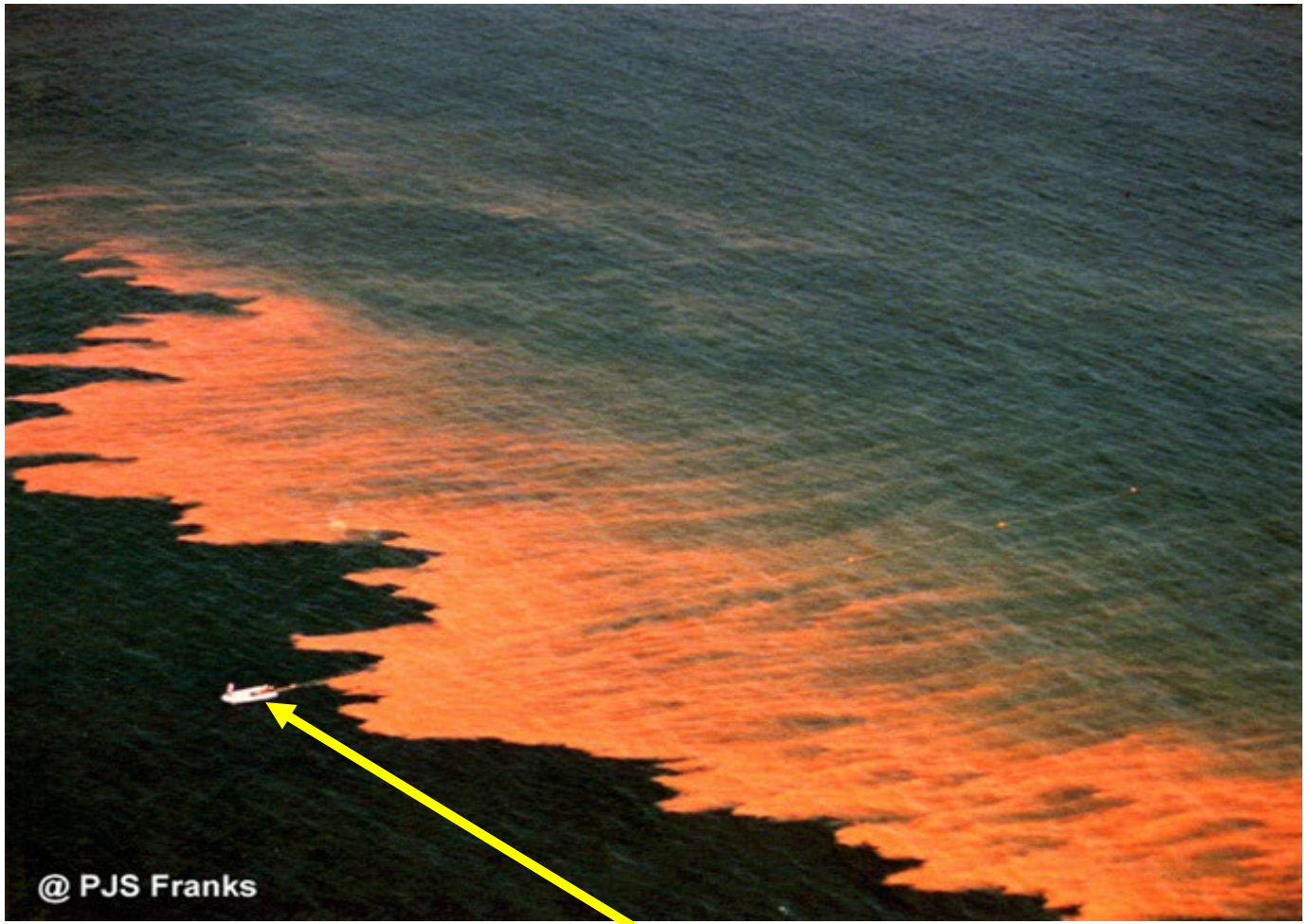
Classic ‘red tide’ image



Bivalve shellfish poisoning

- **DSP** (Dinophysis – Okadaic Acid):
    - Mild symptoms - rapid onset
    - Common in rich fertile water
    - Numerous outbreaks
    - Symptoms < 30mins
    - Diarrhoea, nausea, vomiting, abdominal cramps and chills
    - Recovery in 3 days
    - **Alert level for phytoplankton in seawater = equal to or > 100 cells/litre**
    - **Regulatory limit for DSP:** 160 micrograms of Okadaic acid per kilogram flesh

- Seafish guidance on Diarrheic Shellfish Poisoning (DSP) webpage

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Bivalve shellfish poisoning – continued part 1

- **PSP** (Alexandrium – Saxitoxin):
    - 1987 Central American village = 187 cases 26 dead.
    - Onset 0.4 - 2 hours.
    - Tingling lips – numbness, drowsiness, staggering, fever, rash, paralysis of airways, death, **no antidote**
    - Supportive therapy is the rule - survivors recover fully
    - **Alert level in seawater = > 0 cells/litre**
    - **Regulatory limit for PSP:** 800 micrograms of saxitoxin per kilogram flesh
    - ***Note:*** Forms cysts resting / over wintering stage in the environment

- Seafish guidance on Paralytic Shellfish Poisoning (PSP) webpage

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Bivalve shellfish poisoning – continued part 2

- **ASP** (Pseudo-nitzschia – Domoic Acid):
    - Fatal outbreak in Canada 1987
    - Domoic acid identified
    - Gastrointestinal and Neurological Disorders
    - Gastro-enteritis < 24hrs
    - Nausea, vomiting, cramps, diarrhoea
    - <48 hrs. Dizziness, headache, seizures, disorientation, permanent short-term memory loss
    - Respiratory difficulty, coma and **death**
    - **Alert level in seawater = equal to or >150,000 cells/litre**
    - **Regulatory limit for ASP:** 20 milligrams per kilogram flesh

- Seafish guidance on Amnesic Shellfish Poisoning (ASP) webpage

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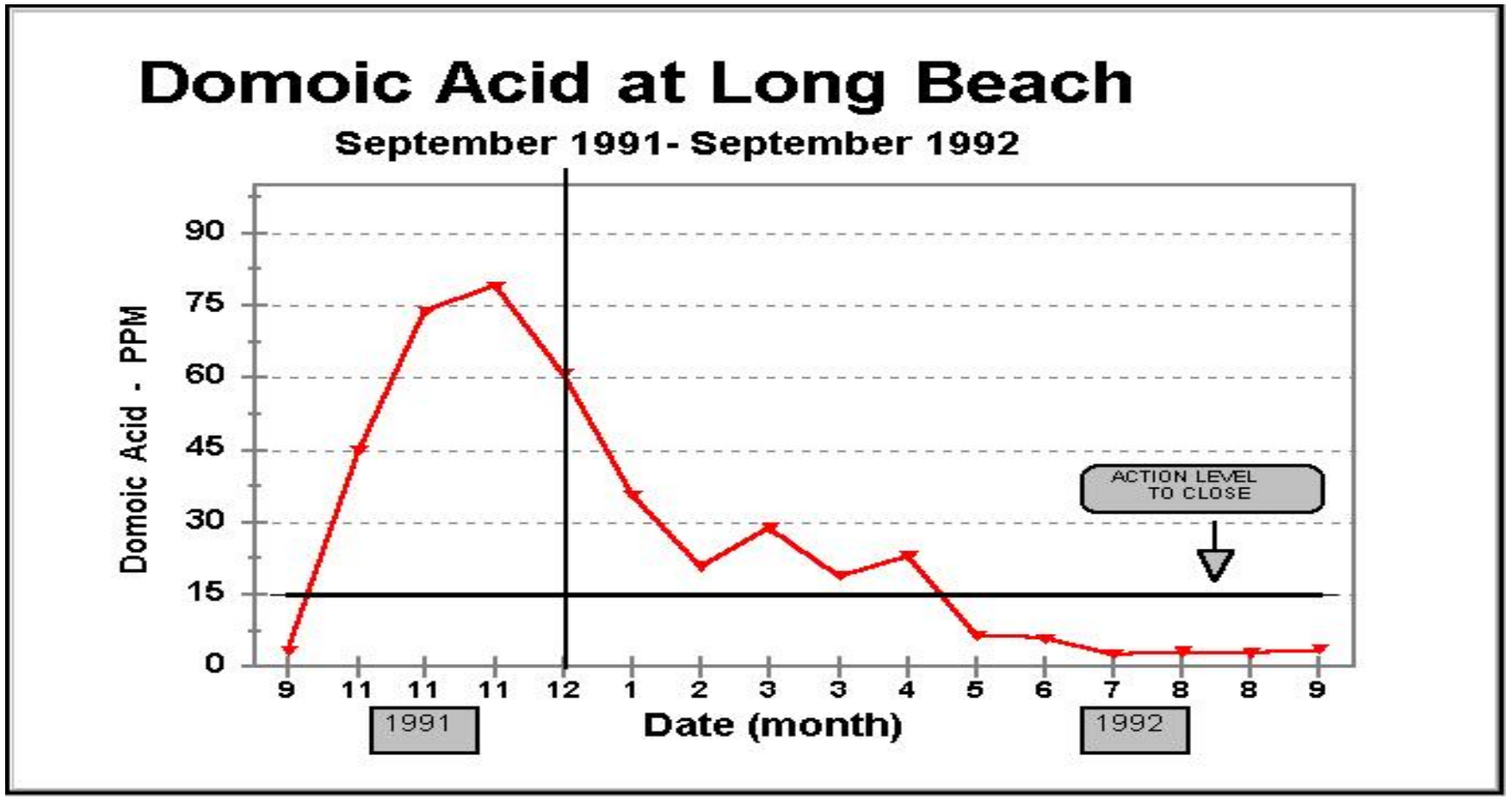
Long term problem



Domoic Acid (ASP) in flesh samples was above action level for 9 months

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Monitoring and testing for HABs

- Sources of information:
    - EU Member States, through LAs, must monitor for toxin producing plankton in bivalve shellfish production/relaying areas, and for biotoxins in live bivalve shellfish
    - FSA Website (*see FSA Handout*)
    - Predictive monitoring – Project ShellEye now has a subscription-based service webpage

- Testing procedures:
    - Based on flesh and water samples
    - Specialist labs / in-house labs / field test kits
    - Chemical testing now replaced animal testing (MBA) for **all** species (effective 1st May 2012 as per FSA)

- Seafish guidance on safer shellfish biotoxin monitoring webpage

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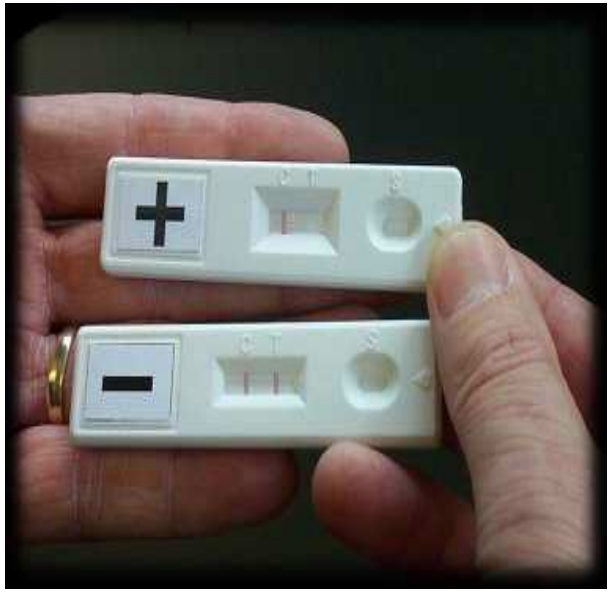
What can industry do about HABs?

- What to do:
    - More intensive and rapid testing now possible
    - Practicality of moving bivalve shellfish?
    - Avoid harvesting until all clear given
- Monitor:
    - Know your area
    - Historical data
    - Know your suppliers
    - **End Product Testing** – due diligence



- Cooperation - work with LA and other local businesses, share data and manage collective risk

- The future – depuration with probiotics?

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The real problem!

- News Article on illicit harvesters - 29/05/12 webpage
- Illicit harvesters and rogue traders

Any questions?

Legislation

V

Food safety law

- Food Safety Act 1990 (UK):
    - Regulation 178/2002/EC.
- EU Assimilated Regulations.
- Includes primary production and ‘live’ food as well as food products.

Food Safety Act 1990

- **Offence:**
    - ‘Unsafe or unfit’
    - Not of ‘nature, substance or quality’
    - Demanded by the consumer
    - Falsely or misleadingly describe food

- **Defence:**
    - ‘**due diligence**’ – took all reasonable precautions …

EU Food Hygiene Assimilated Regulations

- EU Assimilated Regulations 852 and 853/2004 *as amended*
- *2017/625 and 2019/624 (these replace 854 and add further detail re implementing official shellfish controls)*
- Duties of Food Business Operators (FBOs)
- Lays down basic hygiene requirements
- Permanent Management Procedures based on HACCP

Legal definition of clean water

- Legal definition of “**clean”** means that it does not contain harmful quantities of any:
    - Micro-organisms
    - Substances
    - Biotoxins
- Additional technical guidance from **CEFAS**
- Turbidity less than 15 NTU (legal definition vs. guidance)
- No detectable *E. coli*
- Seawater, brackish, fresh
- ***See CEFAS handout***

Sanitary Surveys EU/2017/625

- If the competent authority (FSA) decides in principle to classify a production area or relaying area they must carry out a **sanitary survey** as part of the classification process

- These must be reviewed at regular intervals

- Information on CEFAS Sanitary Surveys webpage

Sanitary survey production

- Make an inventory of the sources of pollution likely to be a source of contamination for the production area
- Examine the quantities of organic pollutants which are released
- Determine the characteristics of the circulation of pollutants in the production area
- Establish a sampling programme of bivalve shellfish in the production area
- Sanitary surveys are now in the public domain

End Product Standards EU/853/2004

- They must have **organoleptic characteristics** associated with freshness and viability, including shells free of dirt (*see Seafish Handout*)
- An adequate **response** to percussion and normal amounts of intravalvular liquid
- *E. coli*, **less than 230 *E. coli*/100g** in flesh and intra-valvular liquid (tested by MPN)
- Salmonella, **absence** in 25g
- They must not contain marine biotoxins in total quantities (measured in the whole body or* any part edible separately) that exceed prescribed limits (see previous End Product Testing Handout for limits)

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End Product Standards EU/853/2004 Cont'd

- Suggestion that x5 samples/year for Salmonella and x1/year for *E. coli* **as a minimum**

- **Note:** Seafish maintain that testing of tank and post-purification product by the regulator is **not** End Product Testing (EPT). Periodic checks that tanks continue to work effectively and EPT **are** the responsibility of industry/FBO based on a risk assessment

- Seafish guidance on End product testing webpage.

Legal requirements for dispatch centres (EU Assimilated Reg. 853/2004)

- When handling live bivalve shellfish, you **must not:**
    - cause contamination of the product or
    - affect the viability of the bivalve shellfish
- Before dispatch, bivalve shellfish **must be** washed thoroughly with clean water
- Live bivalve shellfish **must only come from**:
    - A Class A or B / B-LTC production area
    - A relaying area
    - A purification centre
    - Another dispatch centre, includes dispatch centres onboard vessels

Traceability documents

- **Registration document** – tracks movement of bivalve shellfish from harvester to final distributor:
    - Copies kept at each stage in distribution chain
    - Section VII, Chapter I of Assimilated Regulation 853/2004

Identification Mark – produced by final distributor for use by retailer:

- This applies to all retail packs irrespective of final destination
- Section I, Annex II of Assimilated Regulation 853/2004

Greater scrutiny of compliance in the future!

The Registration document (part 1)

- Must contain at least the following information:

(a)

- (i) the gatherer's identity and address
- (ii) the date of harvesting
- (iii) the location of the production area described in as precise detail as is practicable or by a
- code number
- (iv) the bivalve shellfish species and quantity
- (v) the destination of the batch

And ……

The Registration document (part 2)

(b) In the case of a batch of live bivalve shellfish sent from a relaying area, the registration document must contain at least the information referred to in (a) and the following information:

- (i) the location of the relaying area
- (ii) the duration of relaying

(c) In the case of a batch of live bivalve shellfish sent from a purification centre, the registration document must contain at least the information referred to in (a) and the following information:

- (i) the address of the purification centre
- (ii) the duration of purification
- (iii) the dates on which the batch entered and left the purification centre

Identification mark

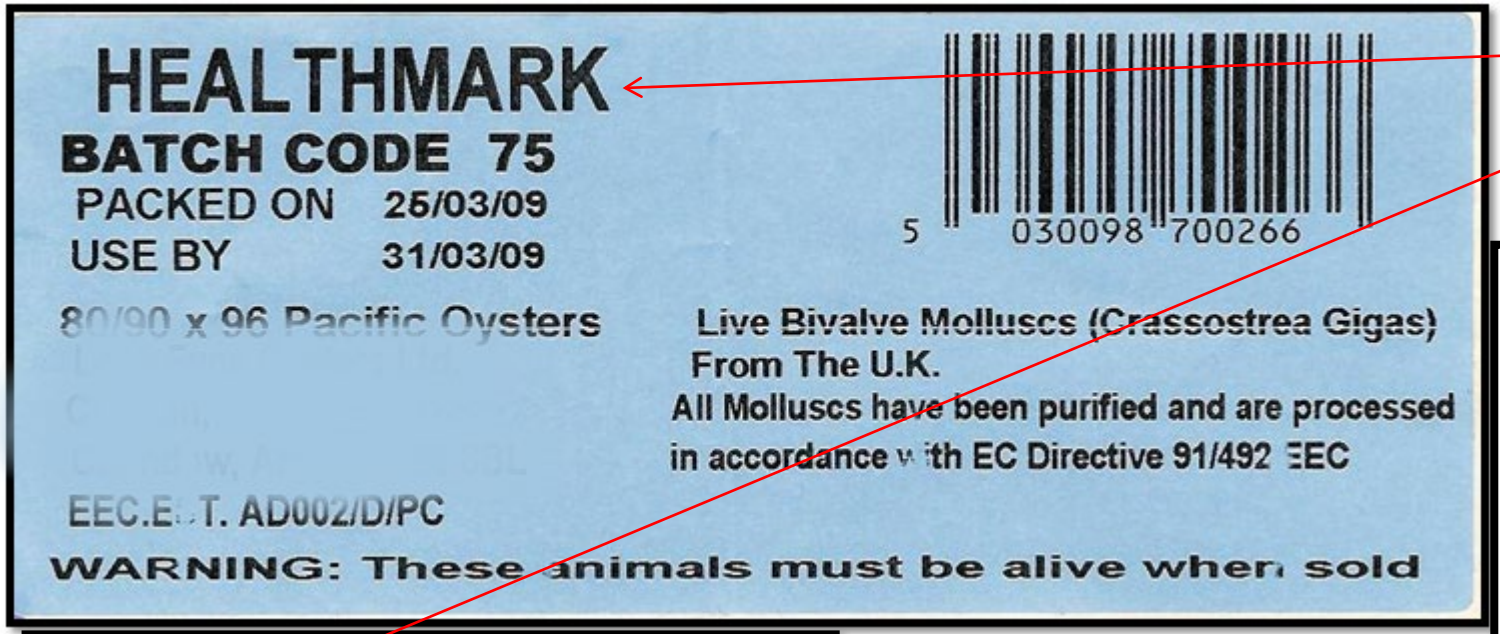
- Live bivalve shellfish must be labelled before leaving the dispatch centre

- **Information must include**:

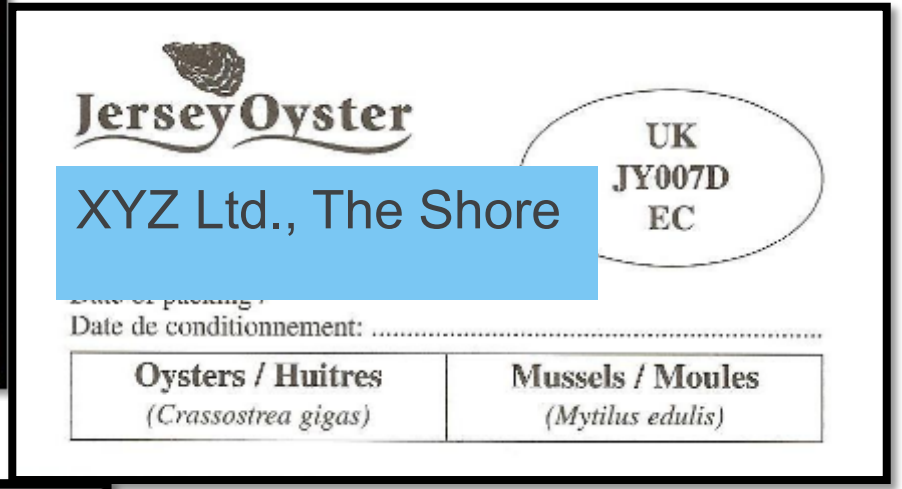
    - Common and scientific name
    - Date of packing
    - Durability mark or ‘these animals must be alive when sold’

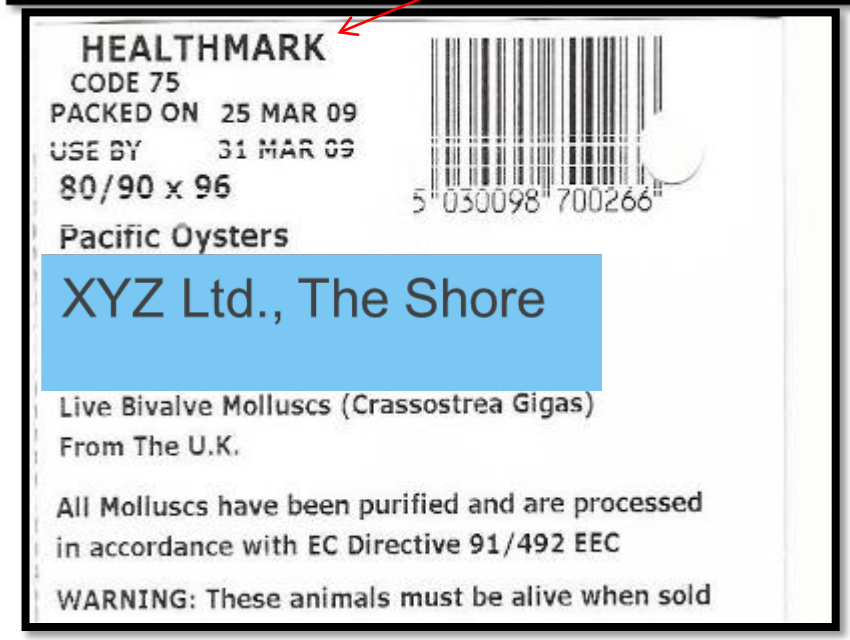
- Centre ID needs to be within **an oval shape**.

- Linked to registration document



Now known as Identification Marks





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Training

- Assimilated Regulation 852/2004, annex II, Chapter XII

- Requires food handlers to be *supervised* and *instructed* and/or *trained* in food hygiene matters **commensurate** with their work activity

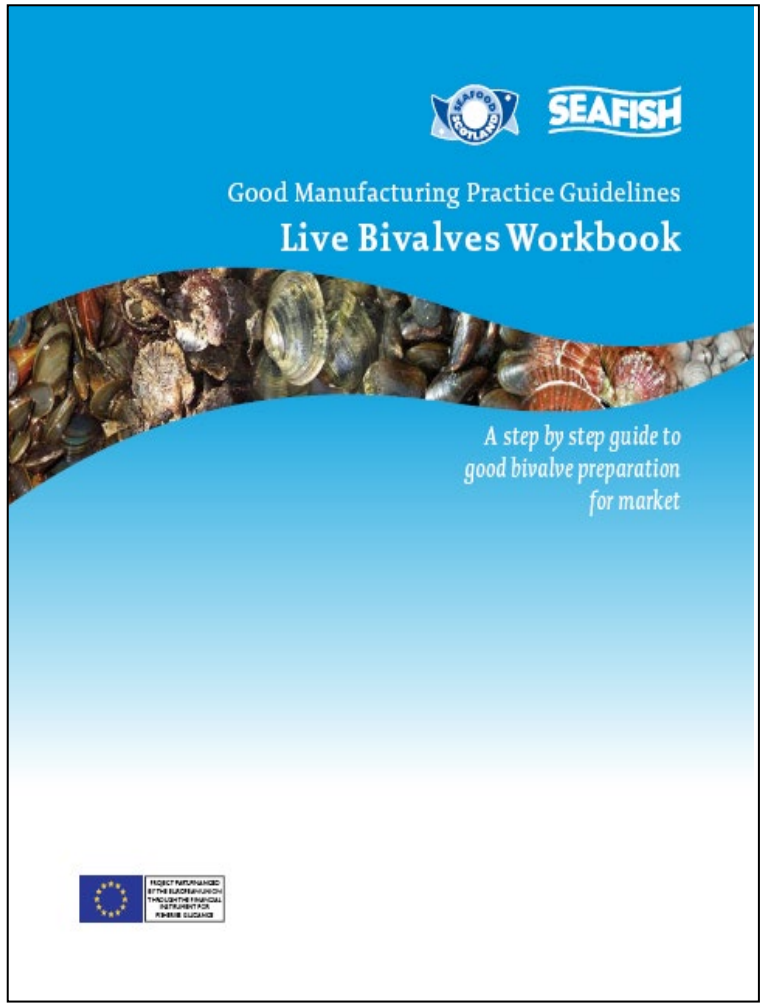
- Requires staff responsible for food safety management to be trained in HACCP

- Who will **supervise and instruct** the manager?

Changes to inspections from 2016

- CEFAS **no longer inspect purification systems** during approval visits
- Use of Conditions of Approval **ceased** i.e. do not form basis of approval
- FBO to demonstrate system is working effectively to produce safe food via **HACCP ***
- Use of reduced purification times possible **if approved by LA** (Note: need to prove efficacy for bacterial contamination & have due regard for viral contamination!)

Good Manufacturing Practice Guidelines



Download a PDF version of the Workbook

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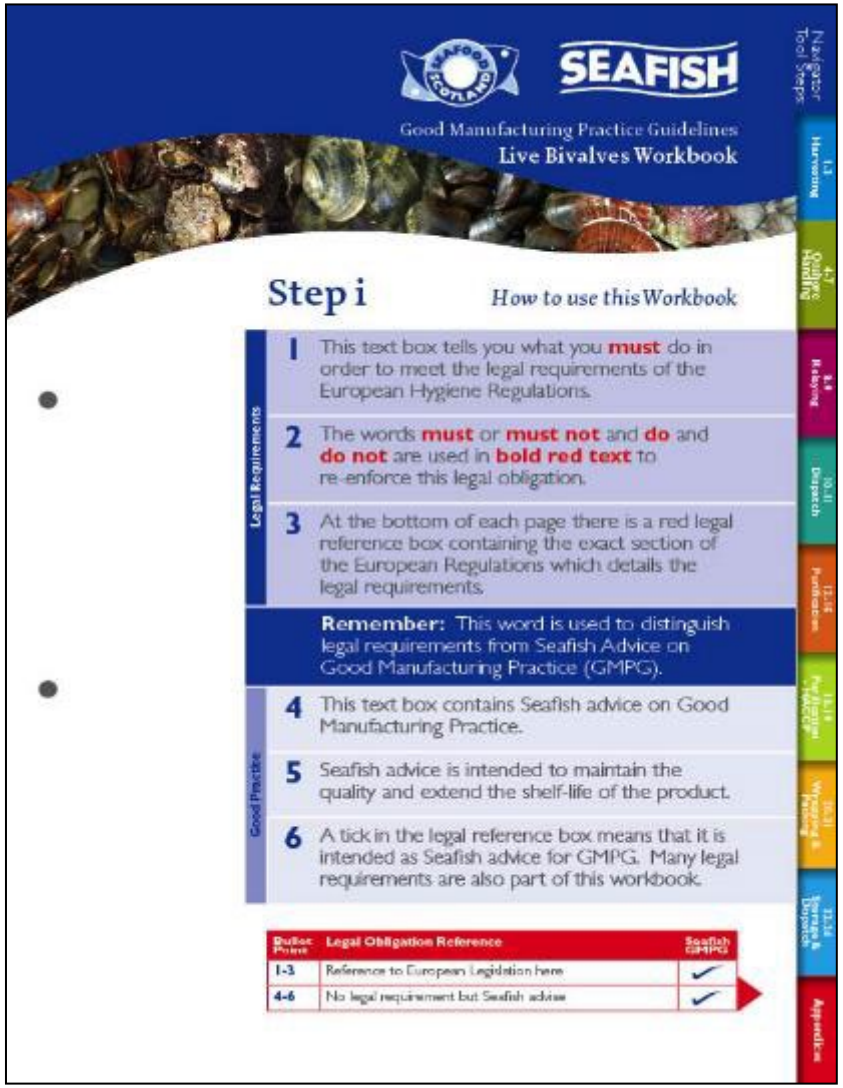
Good Manufacturing Practice Guidelines



- Simply illustrates '**must do's**' with '**nice to have**' / Seafish Good Practice
- Seafish advice goes further than legislation to protect market and consumer needs
- Each step in production from harvest to dispatch
- Relevant to workstation

- **NB**: EU Reg refs are out of date

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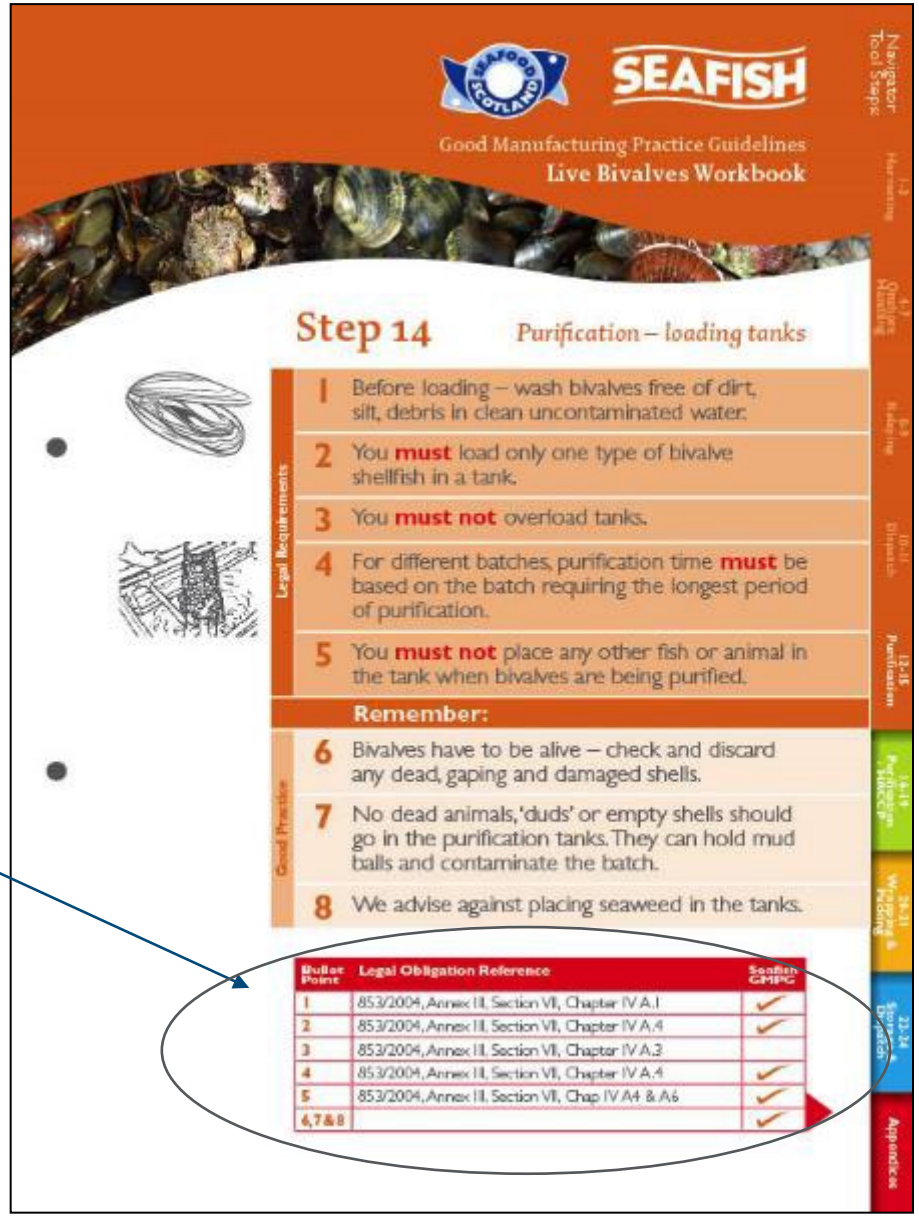
EU references to be updated once transition regulation updates completed.



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Good Manufacturing Practice Guidelines

Live Bivalves Workbook

Step 14 *Purification – loading tanks*

Legal Requirements

1. Before loading – wash bivalves free of dirt, silt, debris in clean uncontaminated water.
2. You **must** load only one type of bivalve shellfish in a tank.
3. You **must not** overload tanks.
4. For different batches, purification time **must** be based on the batch requiring the longest period of purification.
5. You **must not** place any other fish or animal in the tank when bivalves are being purified.

Remember:

Good Practice

6. Bivalves have to be alive – check and discard any dead, gaping and damaged shells.
7. No dead animals, 'duds' or empty shells should go in the purification tanks. They can hold mud balls and contaminate the batch.
8. We advise against placing seaweed in the tanks.

Bullet Point	Legal Obligation Reference	Seafish GMPG
1	853/2004, Annex III, Section VII, Chapter IV A.1	✓
2	853/2004, Annex III, Section VII, Chapter IV A.4	✓
3	853/2004, Annex III, Section VII, Chapter IV A.3	
4	853/2004, Annex III, Section VII, Chapter IV A.4	✓
5	853/2004, Annex III, Section VII, Chap IV A4 & A6	✓
6,7&8		✓

Navigator Tool Steps

Appendices

Environmental requirements of bivalve shellfish

Bivalve shellfish environmental requirements

To purify effectively bivalve shellfish, need:

- Clean water
- Optimum salinity
- Optimum dissolved oxygen
- Optimum temperature range
- No stress or disturbance
- Optimum light levels
- Be able to physically open
- Correct bivalve shellfish to water ratio
- Correct orientation
- Time

Dissolved oxygen saturated seawater at a range of temperatures.

Temperature (°C)	100% oxygen saturation
5	10.0 mg/l
10	9.0 mg/l
15	8.1 mg/l
20	7.4 mg/l
25	6.8 mg/l

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- Mussels in a submerged environment - open, active and filtering!

Water temperature

Species	Minimum purification temperature	Conditioning temperature
Mussels	5 °C	5 to 15 °C
Native Oysters	5 °C	5 to 15 °C
Pacific Oysters	8 °C	8 to 18 °C
Hard Clams	12 °C	12 to 20 °C
Cockles	7 °C	7 to 16 °C
Razors	10 °C	10 to 15 °C

- What is the difference between purification and conditioning?
- Minimum vs. optimum

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Filtering activity vs. temperature – Pacific Oyster

- Impressive filtering and therefore depuration at 22°C, but in practise what will happen?

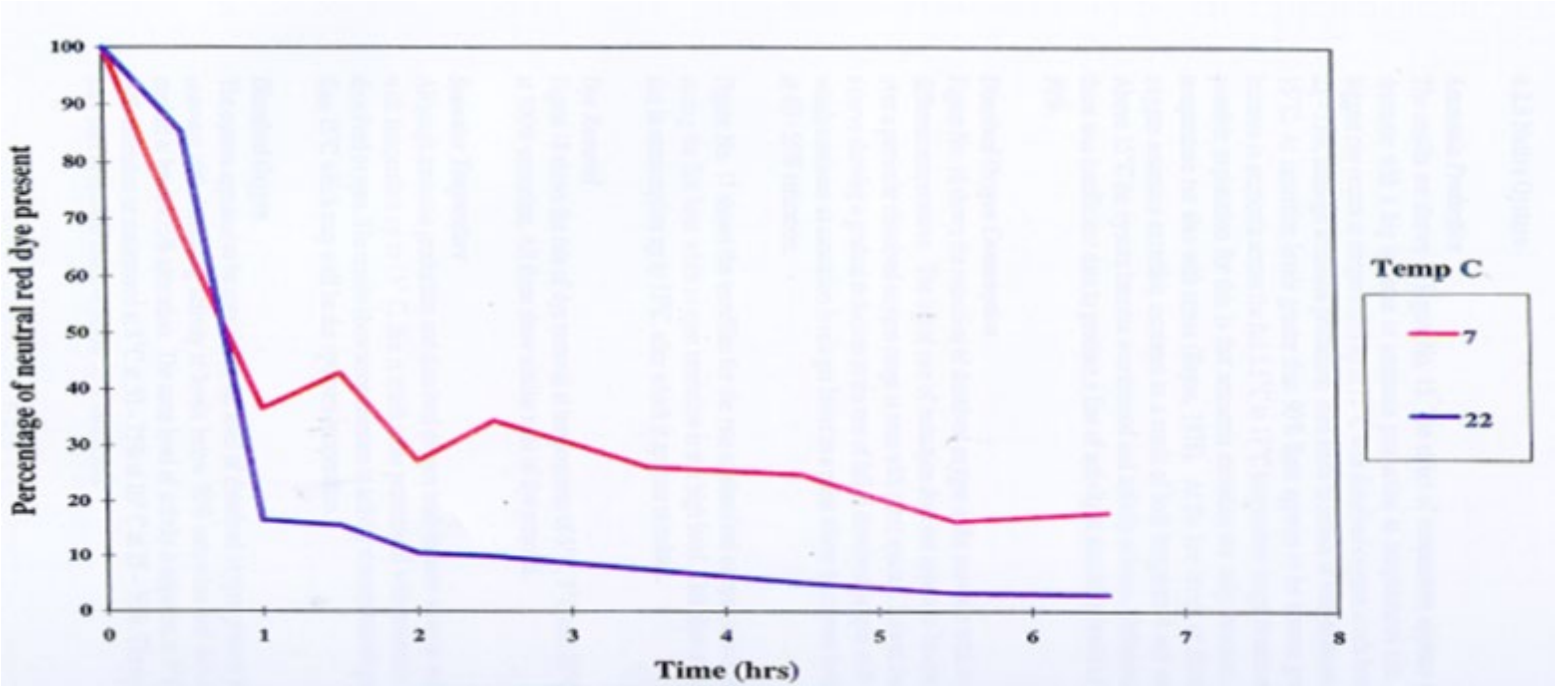
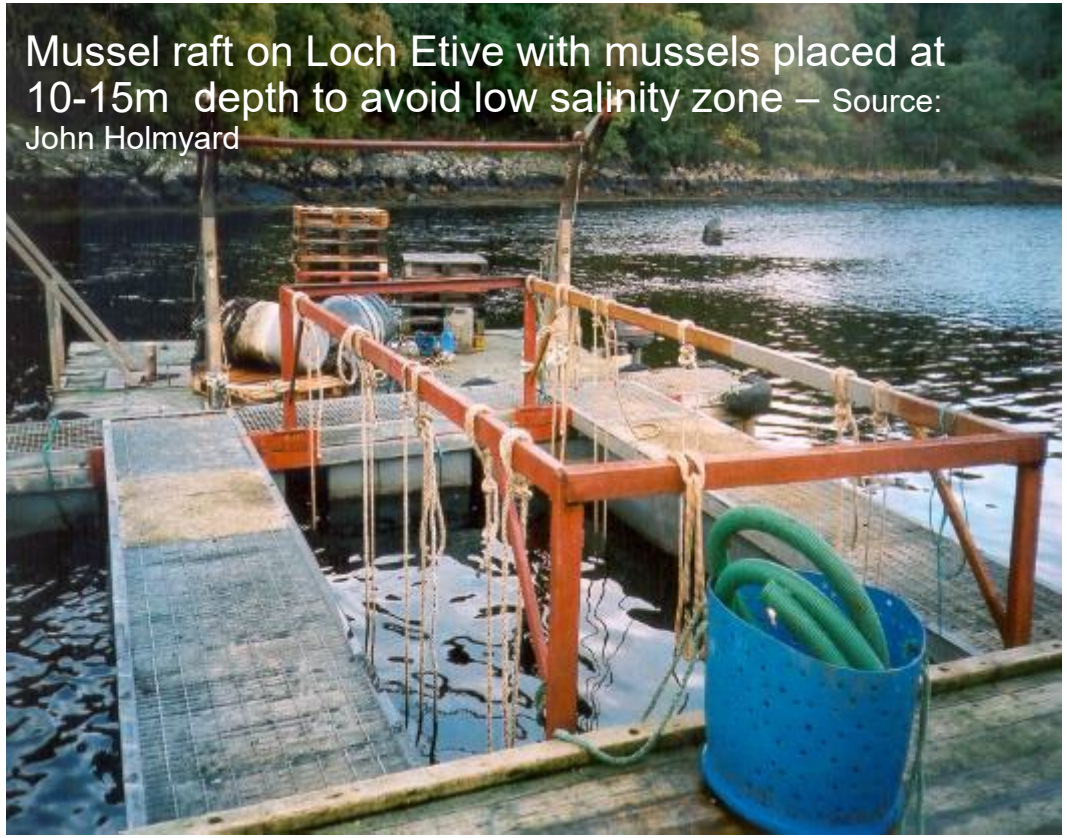


Figure 14 - Pacific Oysters - the reduction in neutral red dye over time at 100% dissolved oxygen and different temperatures

Minimum salinities for depuration

- Native Oysters 25 ‰
- Pacific Oysters 20.5 ‰
- Clams 20.5 ‰
- Mussels 19 ‰
- Cockles 20 ‰
- Razors 30 ‰

Note: ‰ is parts per thousand (ppt).



Mussel raft on Loch Etive with mussels placed at 10-15m depth to avoid low salinity zone – Source: John Holmyard

Good practice: Salinity within 20% from where bivalve shellfish gathered.

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Monitoring equipment

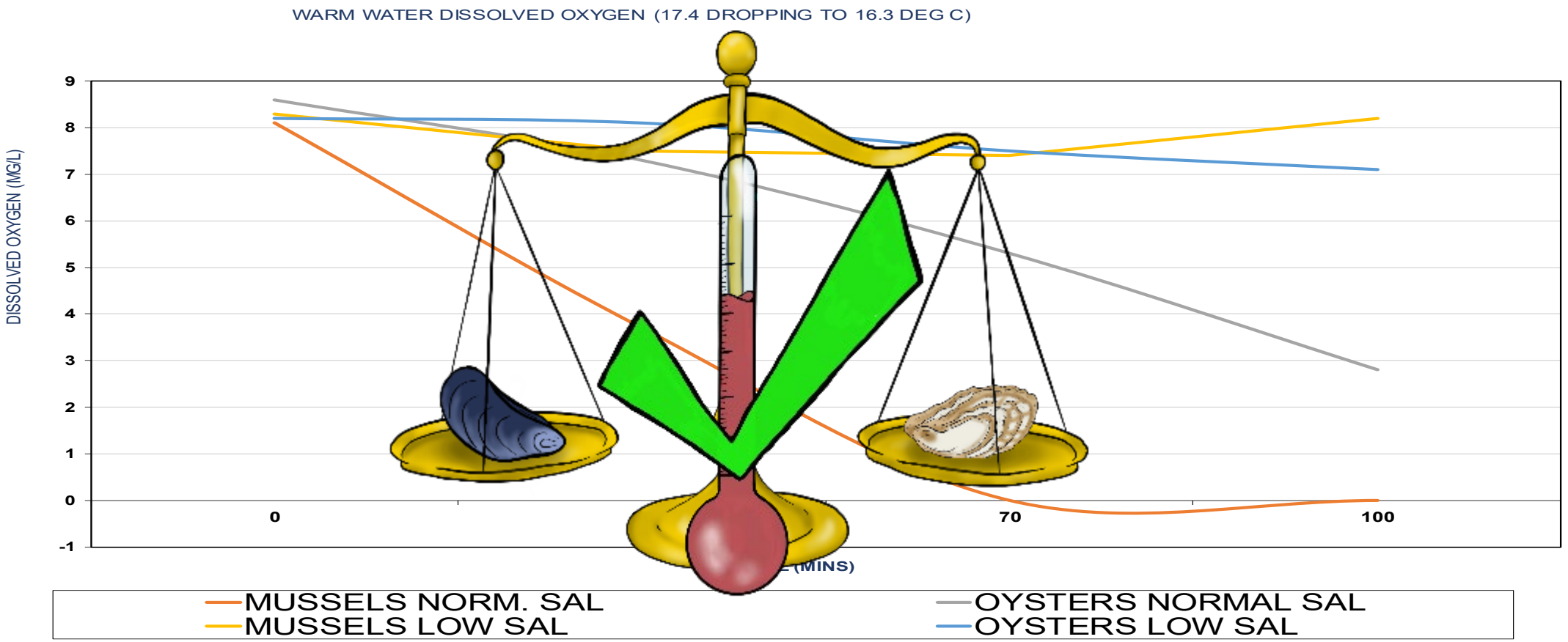
- Thermometer
- Hydrometer
- Dissolved Oxygen (DO) meter
- Turbidity meter
- Other equipment?

  e.g. Test for ozone residues using ozone meter.

- **Ensure regular correct calibration!**

Why you need to check DO, salinity and temperature?

IN STATIC TANK, **NOT** IN AERATED DEPURATION TANK.



NATIVE **PACIFIC**

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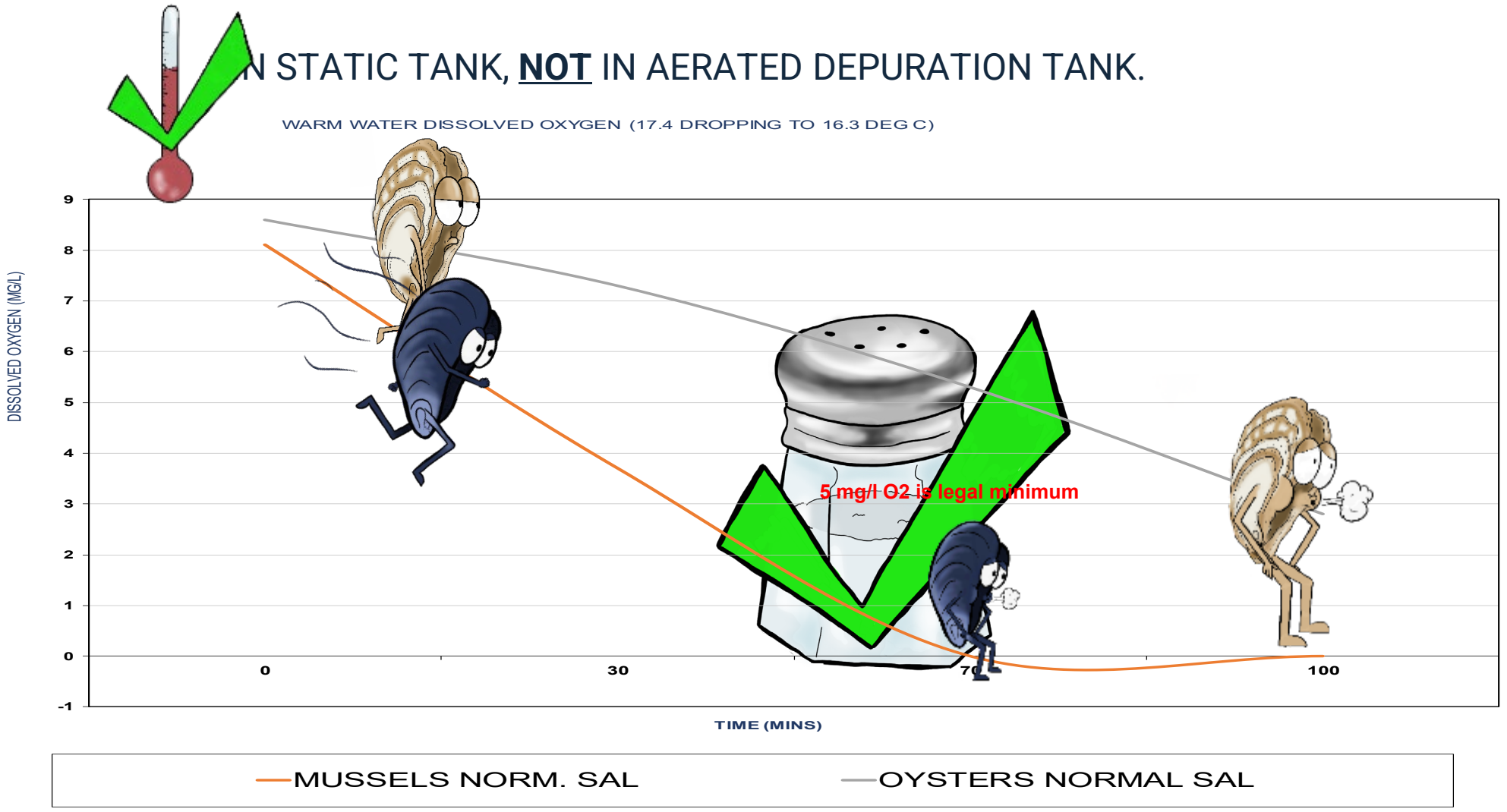

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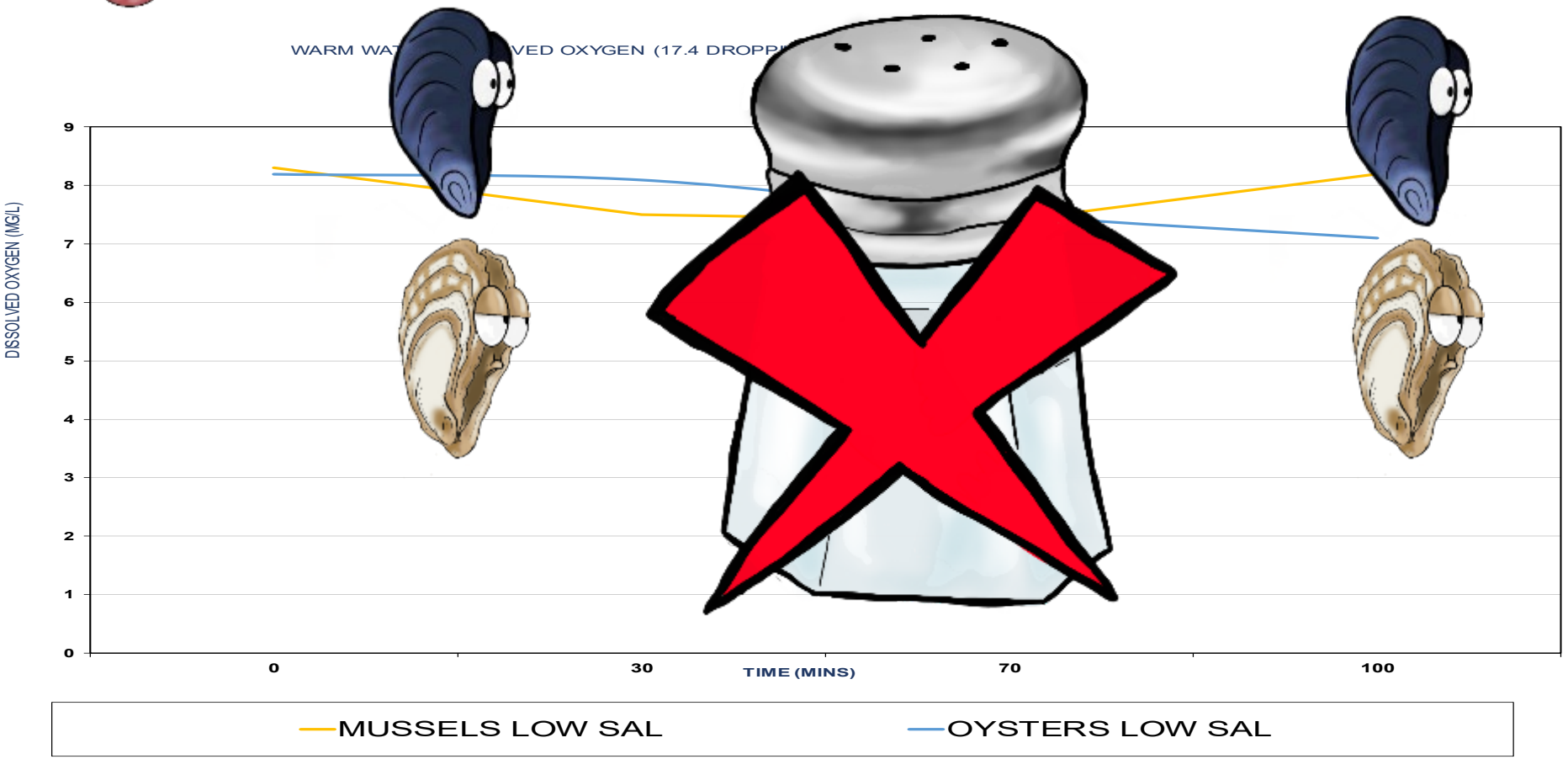

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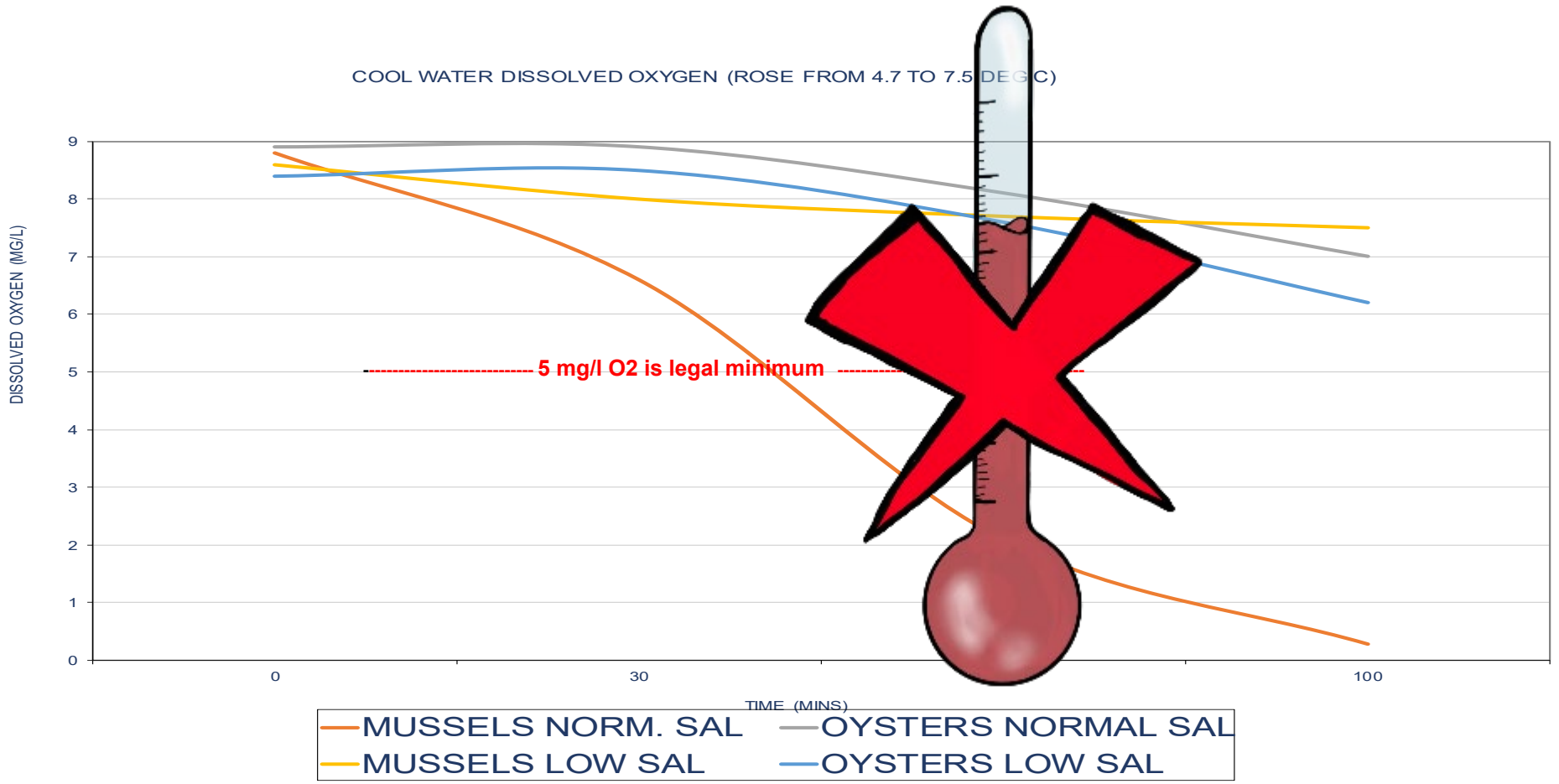

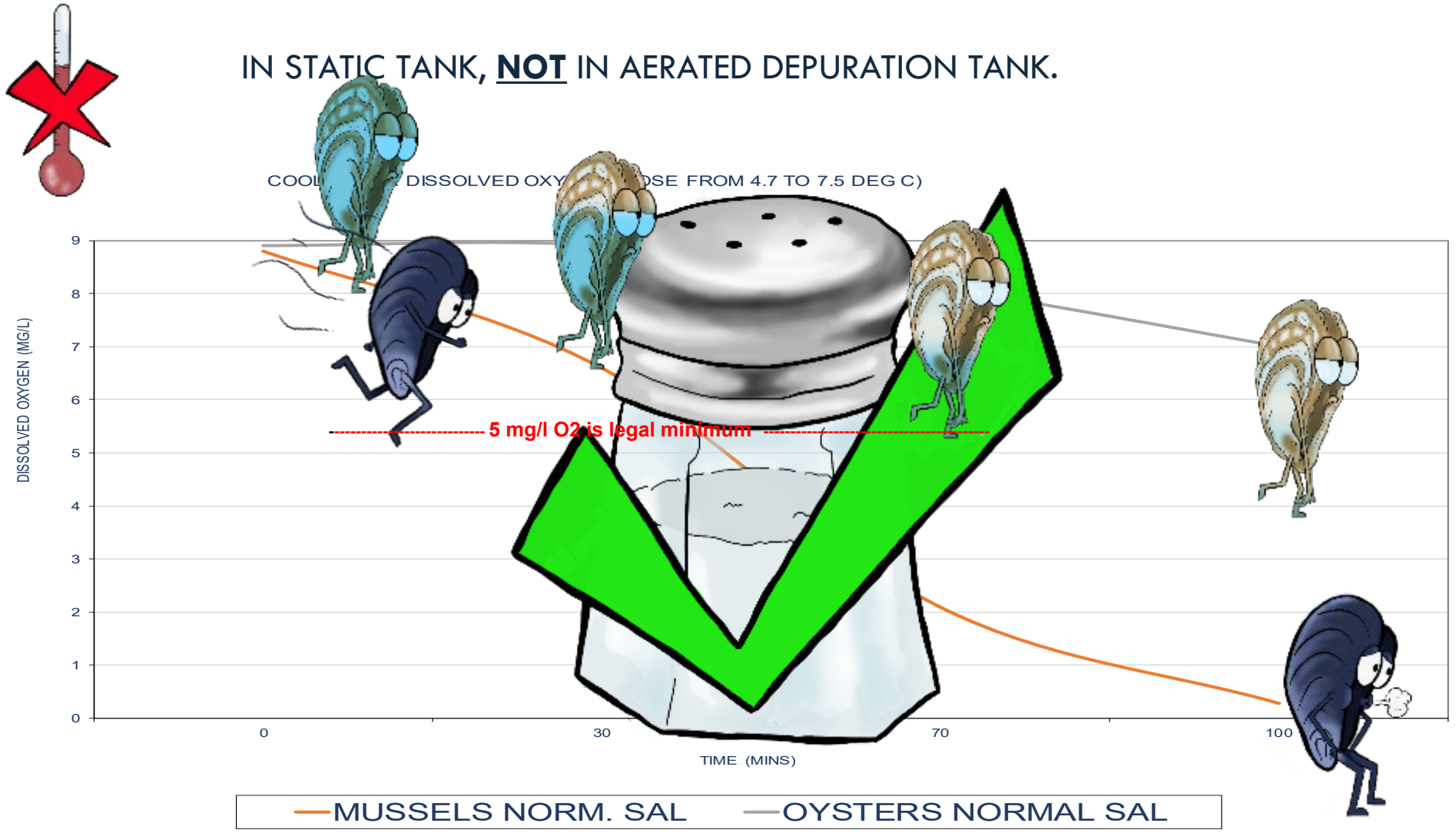
IN STATIC TANK, NOT IN AERATED DEPURATION TANK.
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DISSOLVED OXYGEN (MG/L)
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5 mg/l O2 is legal minimum
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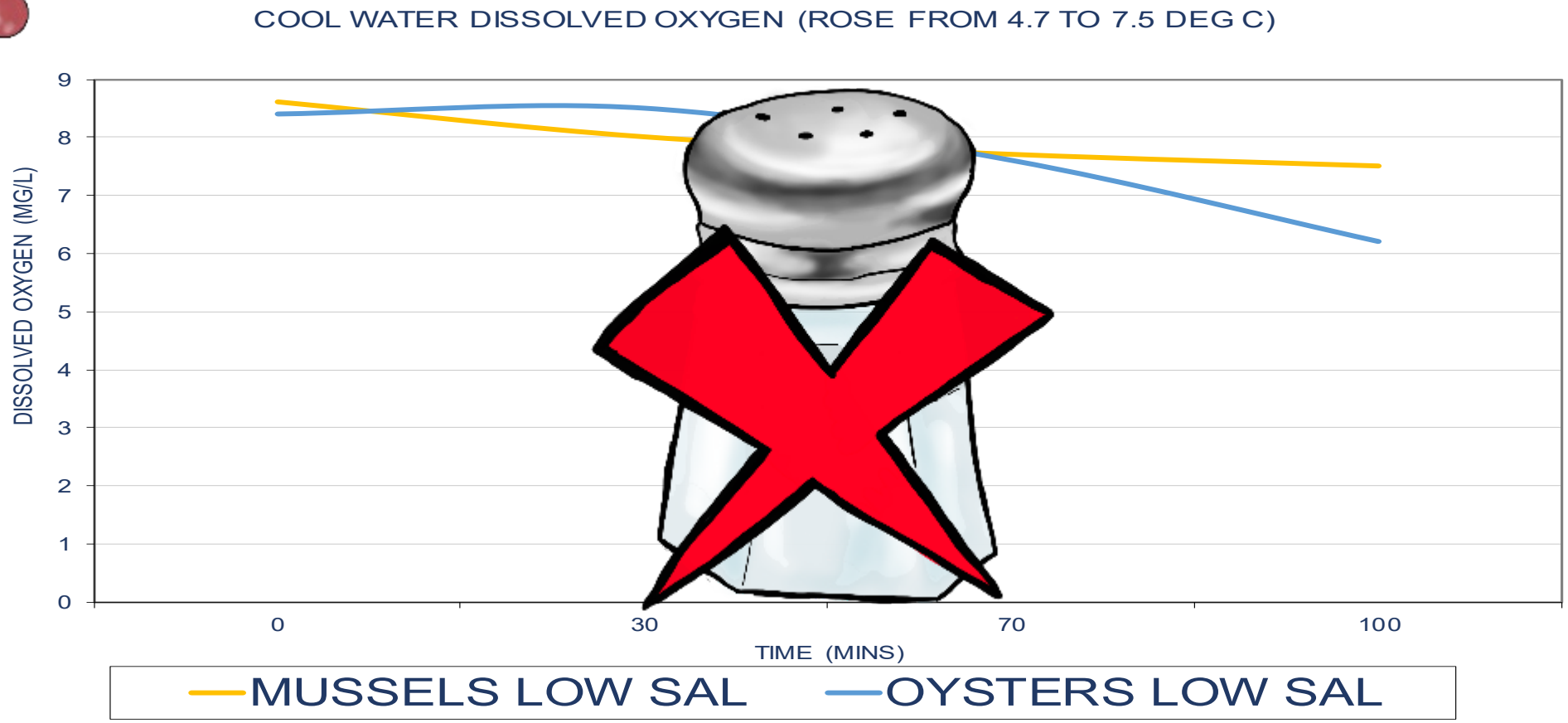
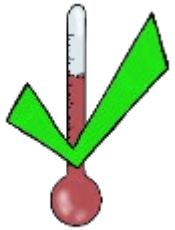
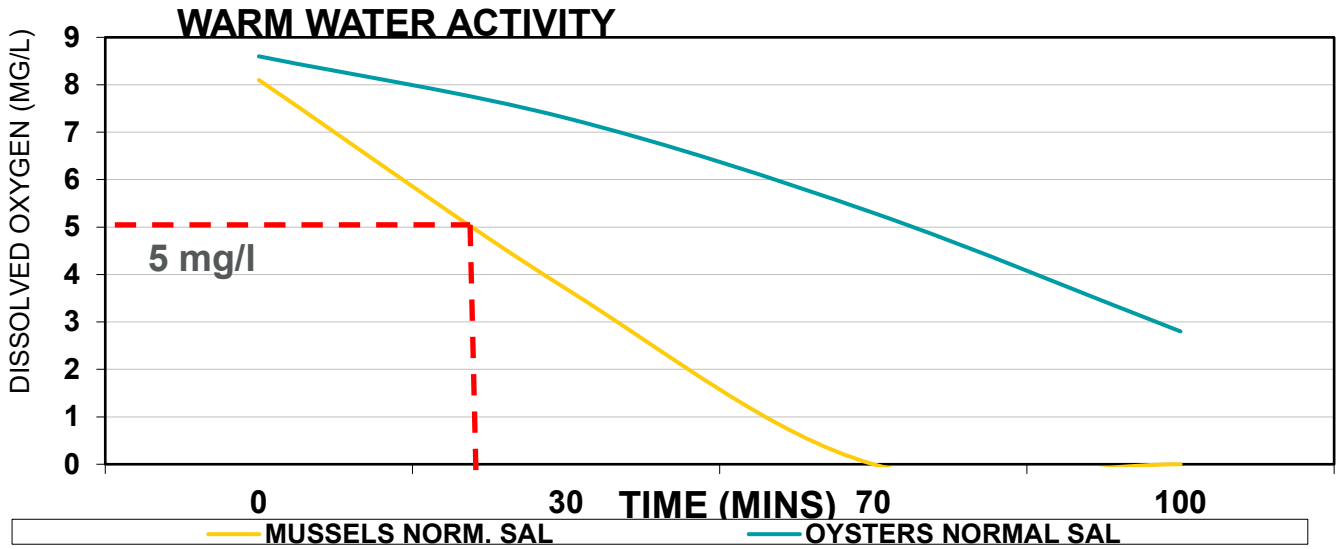
TIME (MINS)
MUSSELS NORM. SAL
OYSTERS NORMAL SAL

IN STATIC TANK, **NOT** IN AERATED DEPURATION TANK.






WARM WATER ACTIVITY
DISSOLVED OXYGEN (MG/L)
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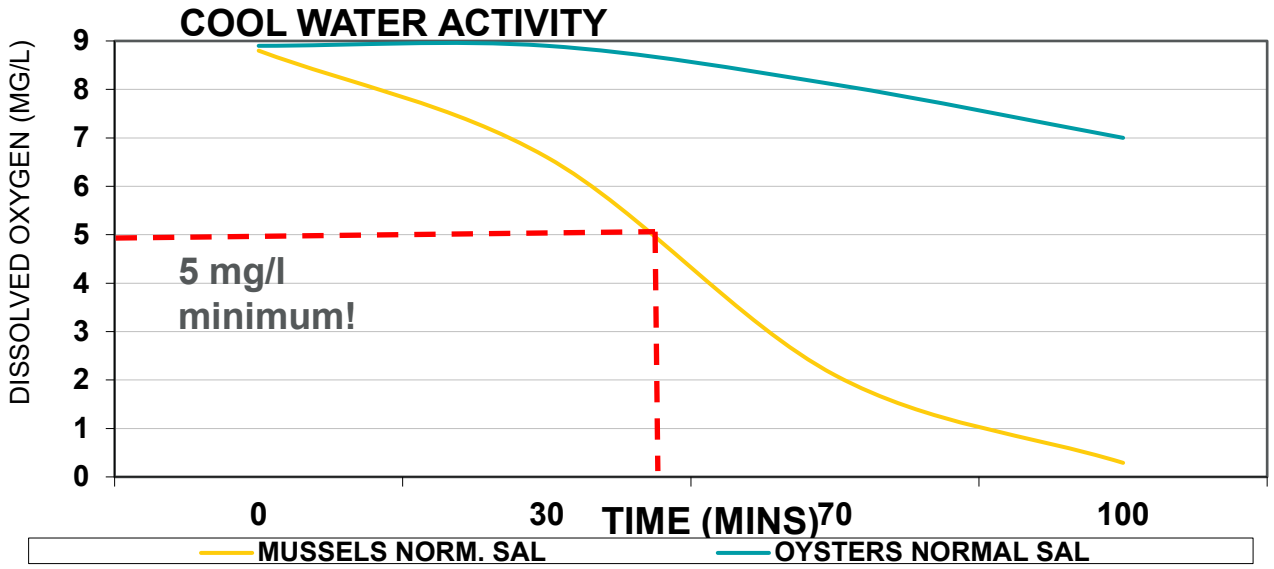
5 mg/l
0
30
TIME (MINS)
70
100
MUSSELS NORM. SAL
OYSTERS NORMAL SAL


COOL WATER ACTIVITY
DISSOLVED OXYGEN (MG/L)
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5 mg/l
minimum!
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30
TIME (MINS)
70
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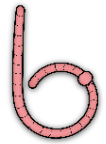
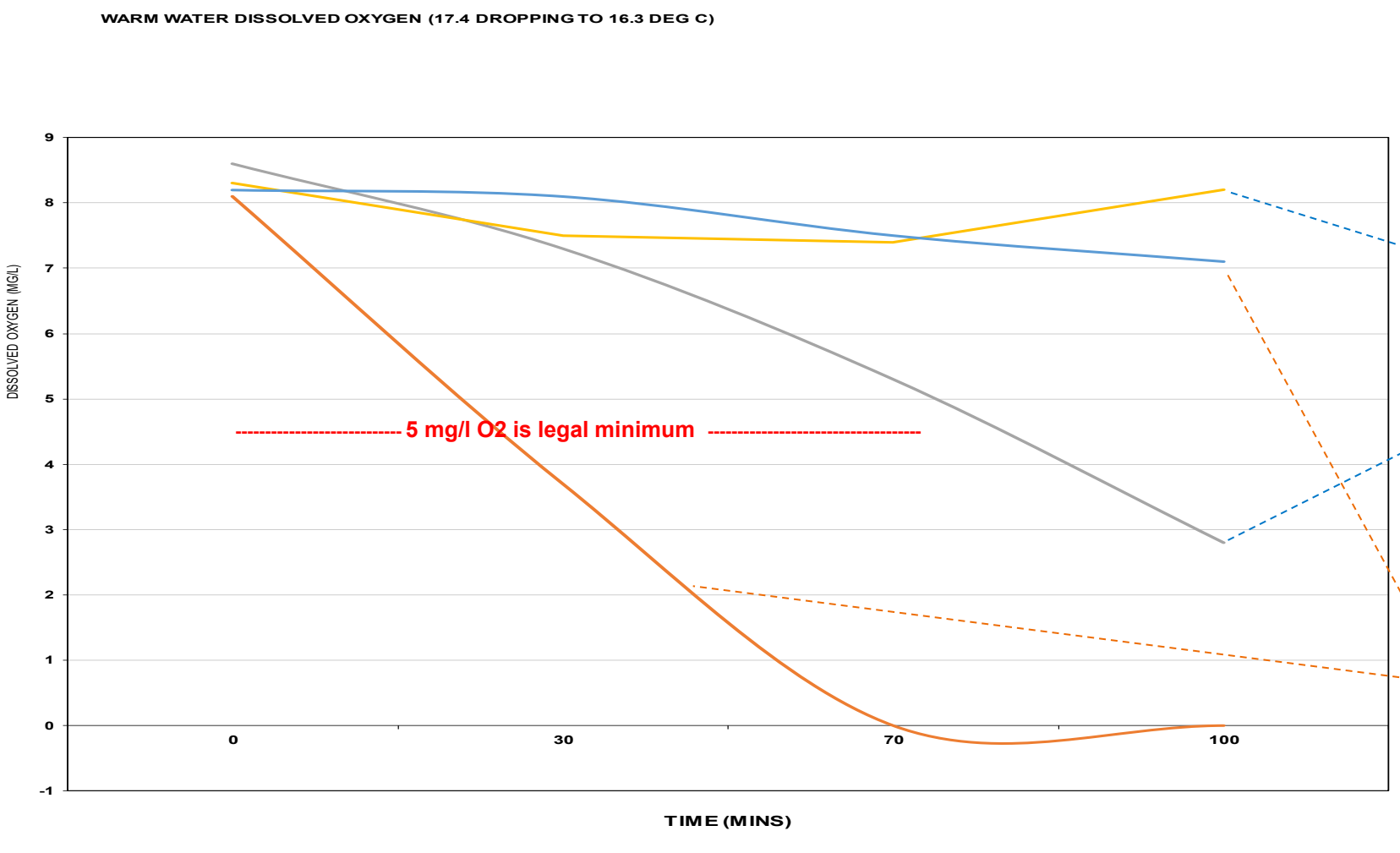
MUSSELS NORM. SAL
OYSTERS NORMAL SAL



Why you need to check DO, salinity and temperature?



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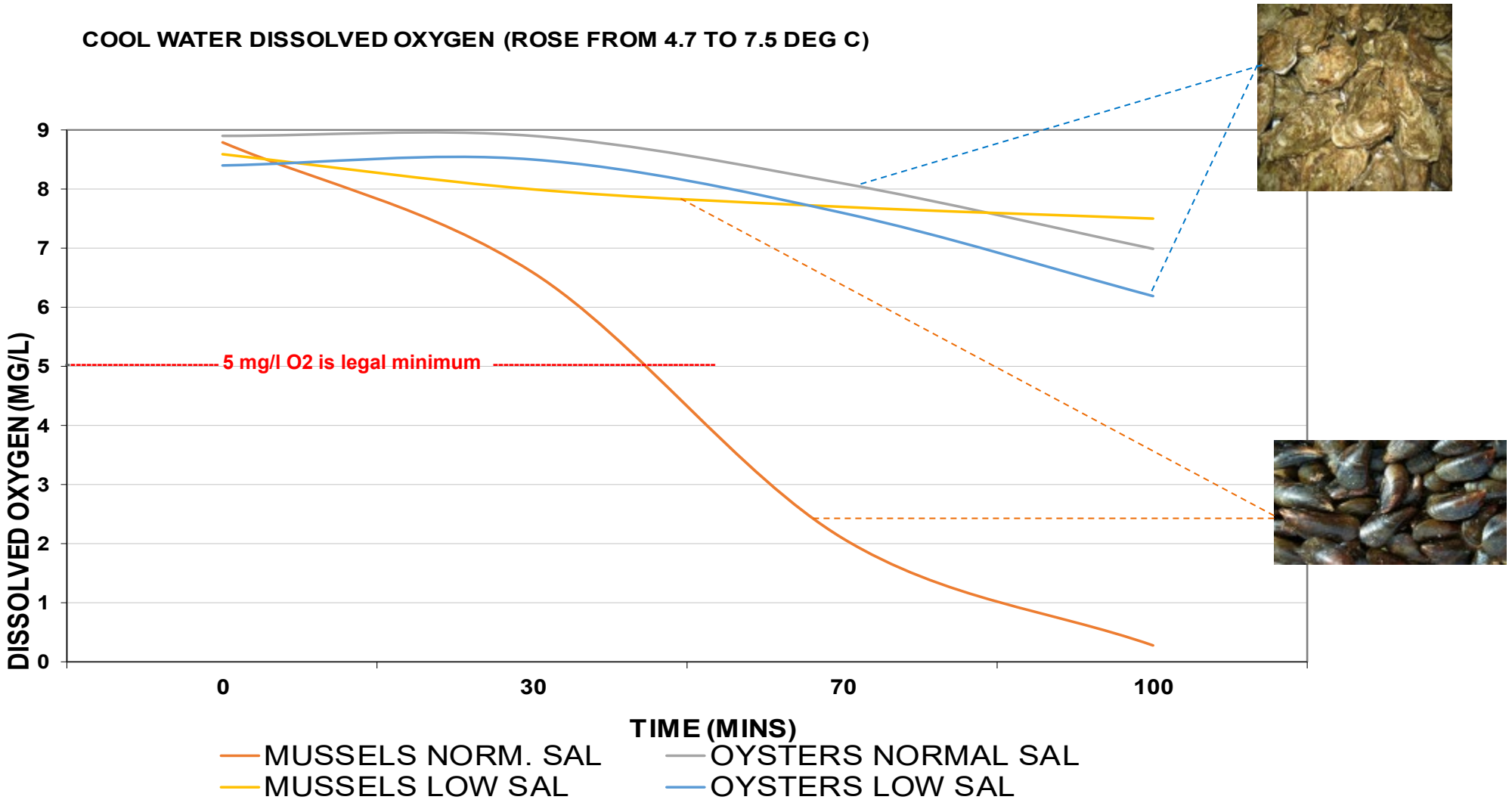
COOL WATER DISSOLVED OXYGEN (ROSE FROM 4.7 TO 7.5 DEG C)
DISSOLVED OXYGEN (MG/L)
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0
30
70
100
TIME (MINS)
MUSSELS NORM. SAL
MUSSELS LOW SAL
OYSTERS NORMAL SAL
OYSTERS LOW SAL

Risk management and record keeping

HACCP

- **Hazards:**
  - Something with the potential to cause harm

- **Risks:**
  - A hazard that has been measured and quantified

- **Critical Control Points (CCPs):**
  - Those points during purification where hazards are controlled
  - Not every step in the process is Critical!

- **Hazard Analysis Critical Control Points:**
  - Food Safety Management System (*see handout)*
  - Legal requirement!

The seven principles of HACCP

1. Identify any hazards that must be controlled in order to reduce risk. (Conduct a risk assessment, prepare a flow diagram, list hazards and specify control measures)

2. Identify CCPs using a decision tree

3. Establish target levels and tolerances

4. Establish monitoring systems

5. Establish corrective actions

6. Establish documentation to prove the above

7. Establish verification and review procedures

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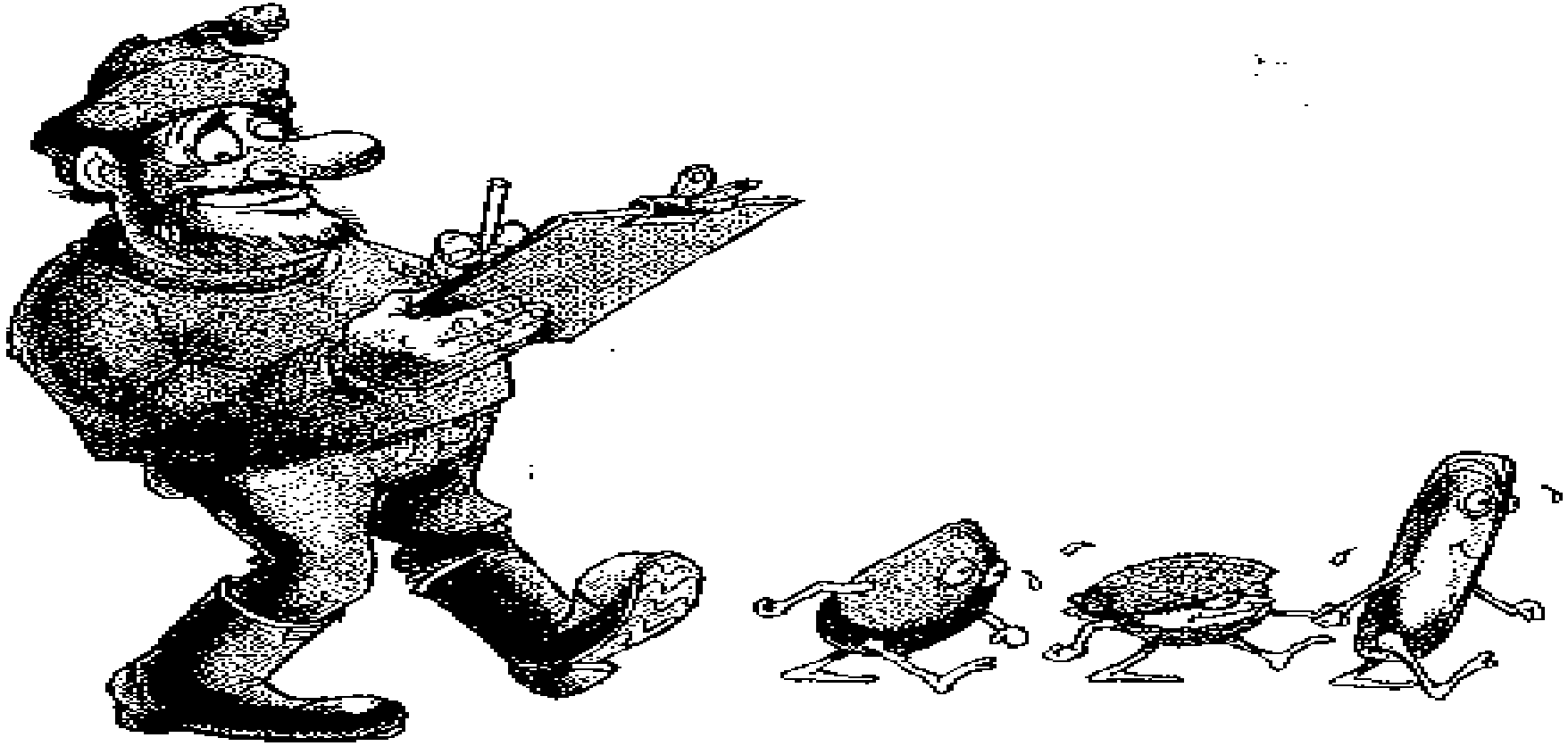
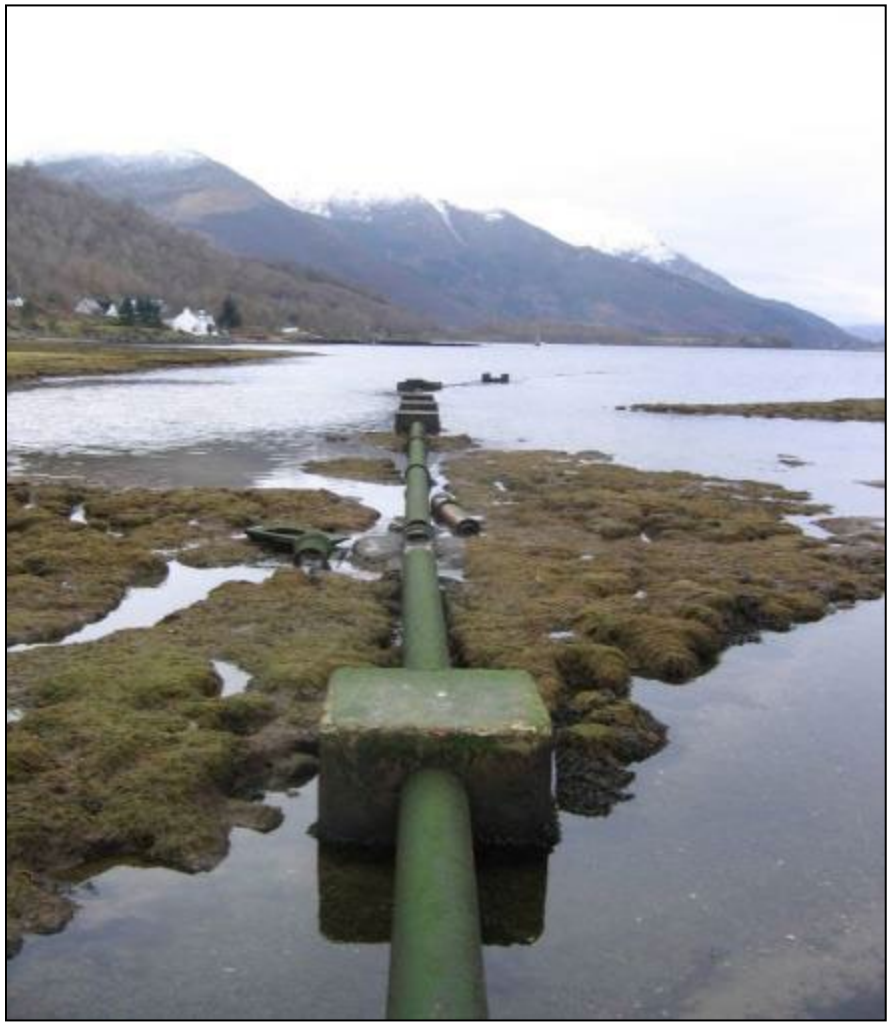
Hazard identification and control procedures



Carrying out a risk assessment

- Start with blank sheet - flow diagram
- For each step - consider hazards to food safety
- For each hazard - consider practical measures
- Implement controls for each hazard

Know your hazards



Hazards and inadequate controls

- Inadequate environmental information
- Lack of information on source of bivalve shellfish
- Leaving lying around
- Exposure to further contamination
- Temperature abuse
- **<42 hrs. without LA approval**
- Stress

Hazards - contamination

- **Cross contamination** -

  from another source

- **Recontamination** -

  after purification

Group: list the situations when cross contamination or recontamination could occur?

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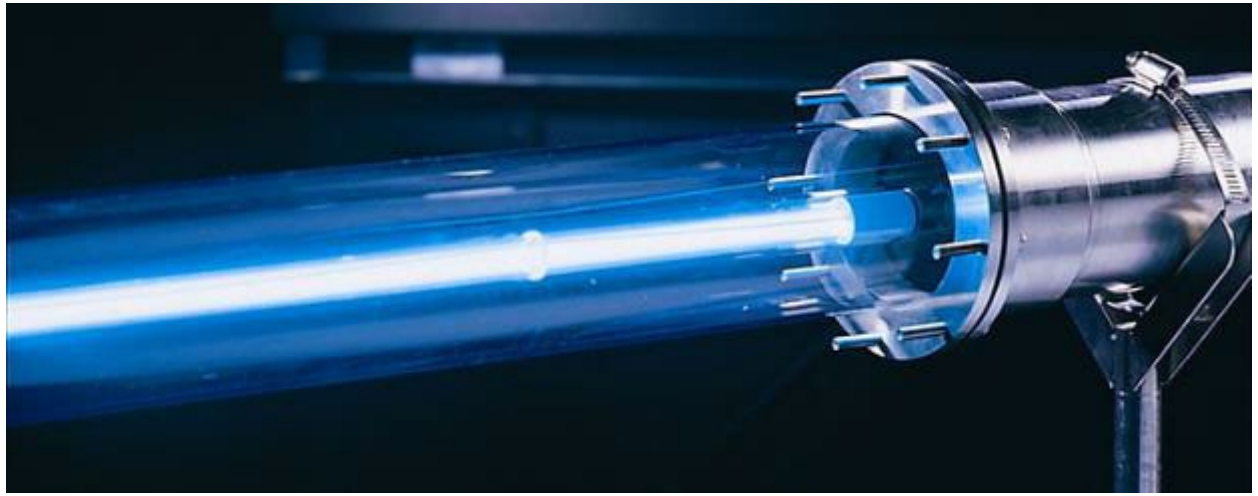
Food safety - CCPs

- Group list these:

Food safety - CCPs

- Source of bivalve shellfish
- Tank is not overloaded
- UV is working
- Others



Appropriate control measures

- Insist on registration document / unique batch number for **EVERY** batch

  (e.g. Prod. area/Julian date/Tank no.)

  Reg. 178: Batches separate, identifiable

- Move directly from transport to protected storage or preparation area

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Checks on control measures

- Keep **ALL** records of:
  - Deliveries
  - Registration documents
  - Batch numbers
- Keep all *permanent management procedure* records, food safety, legal documentation
- Adequate supervision and motivation of staff to follow best practice.

Documents

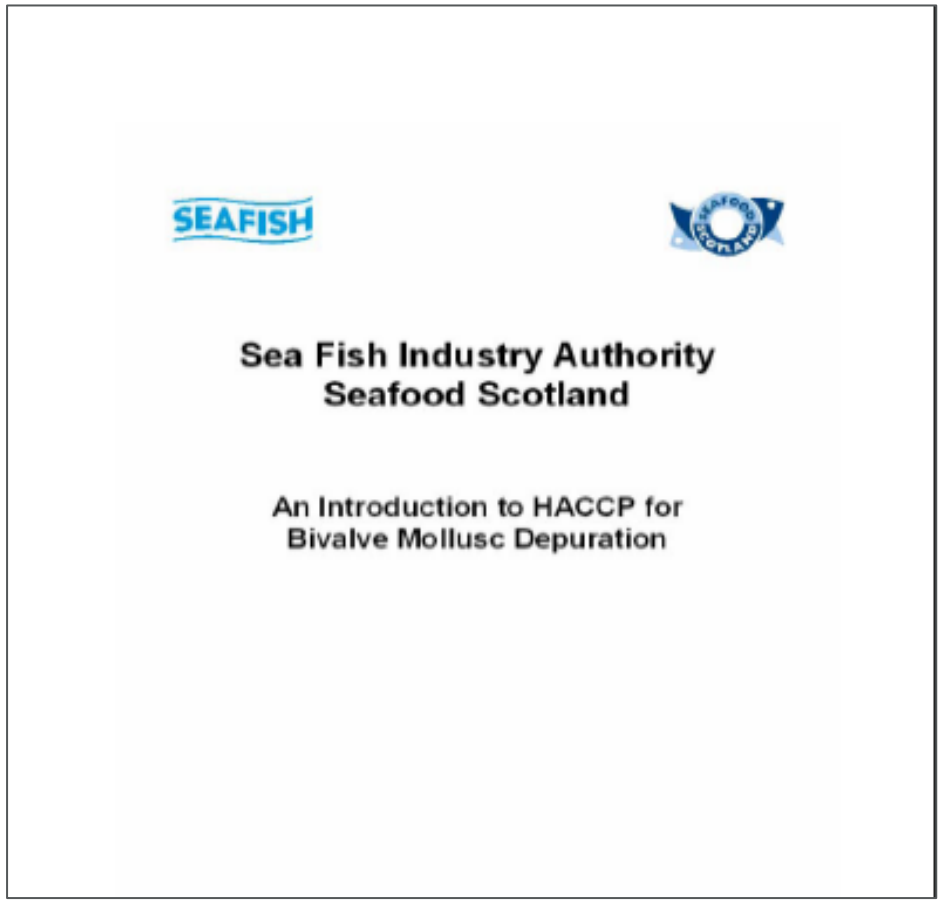
- All keyed to original movement document
- Permanent movement authorisation, use batch number
- Chronological order
- Diary of events
- Cleaning, maintenance and vermin schedule

Example record sheets

- Bivalve shellfish reception
- Purification system operation:
  - CEFAS standard systems sheet
  - CEFAS ozone systems sheet
- Product dispatch
- Bacteriological testing

What other types of records are needed as part of a HACCP based permanent management system?

Permanent Management Procedures (PMP) based on HACCP are required



- *EU Regulation 2019/627*
- Change of business ownership requires reapproval
- My HACCP is a useful tool
- Seafish guidance on HACCP Plans for Bivalve Purification Operations webpage

42 hour vs. reduced purification times

- From 2016, FBOs allowed to apply alternative purification times (*see Seafish Handout*)
- FBO must prove that systems remain effective and operate under an appropriate HACCP-based system
- FBOs must consider all relevant hazards, including viral as well as bacterial contamination
- Evidence must be provided to LA that time period is effective and EPS are met
- Use of reduced periods must be under constant review as part of a HACCP-based system and time periods increased if threat levels change/increase

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Considerations with reduced purification cycles

- **Species –** e.g. differing filtration rates between species and with changing environmental variables (such as temperature)

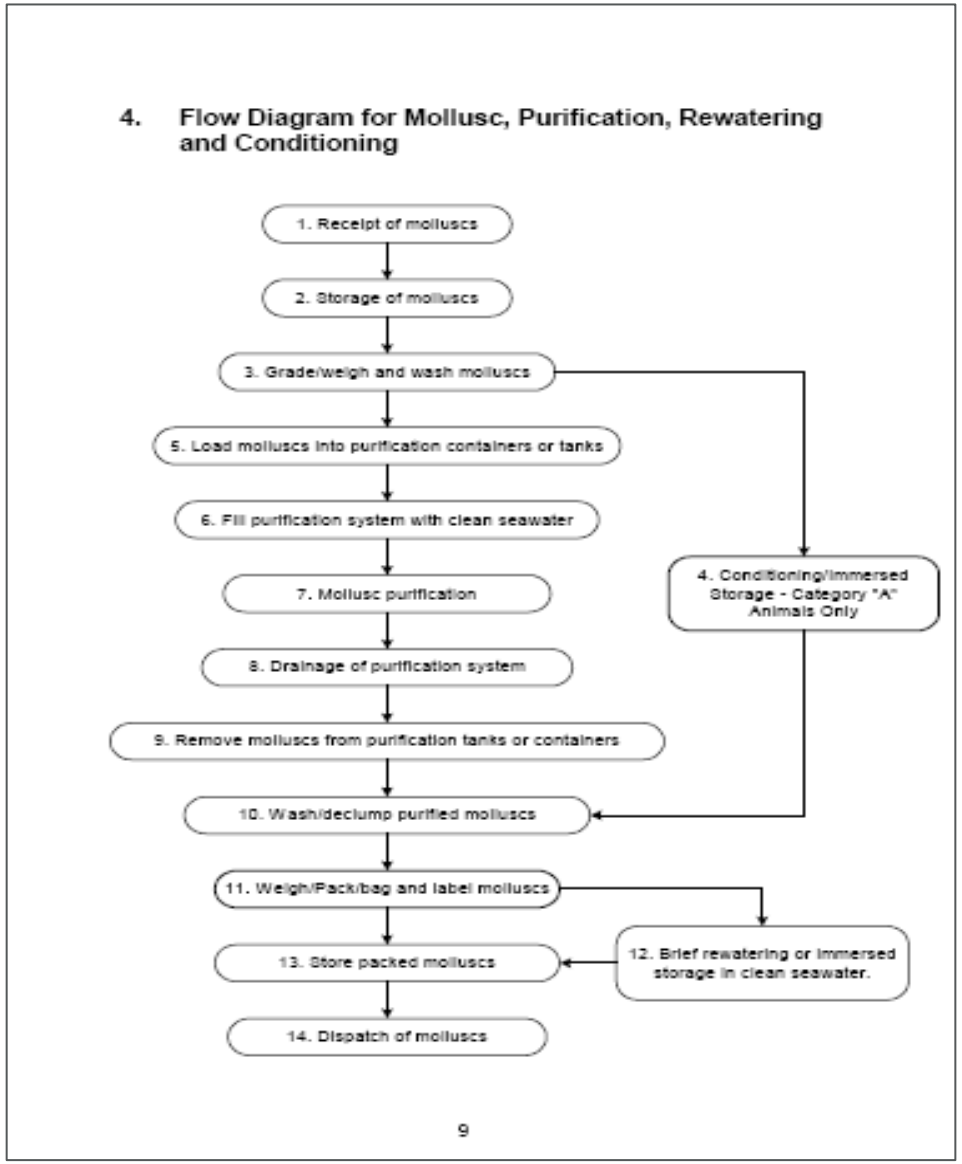
- **Time of year and associated contamination risks -** e.g. when higher levels of norovirus are present in the population (*Note*: Requires assessment of bacterial and viral contamination risks)

- **Recent weather –** e.g. heavy rainfall events

- **Recent official control monitoring results –** i.e. classification results

- **Other information -** e.g. pollution events, algal toxins

- **Seafish guidance:** Assessing Risk Based Reduction in Purification Times for Bivalve Molluscs webpage



- Many resources for FBOs can be found in the **Seafood Academy Library**.

- Bivalve Purification – A library guide for food business operator's webpage.

Don’t forget

- Live bivalve shellfish are a high care food product
- Staff should be instructed to report any food safety issues to management
- Due diligence ... take all reasonable precautions:
    - Follow industry best practice (use GMPG)
    - Monitor and record
    - Train and supervise staff
    - Keep up to date

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Depuration tank design and operation

Basic principles

- **Water source and usage:**
    - Natural or artificial
    - Single pass or recirculation
- **Disinfection method:**
    - UV, ozone, chlorine or hybrid
- **Temperature, dissolved oxygen and salinity:**
    - Monitored but not controlled
    - Active environmental management
- **System capacity and handling:**
    - Multiple small or medium capacity units vs. fewer, larger units
    - Manual or mechanical loading/unloading
- **Duration of purification cycle**

The role of disinfection in seawater

- Why do we need disinfection equipment?
    - To ensure a **clean water supply**
    - To **prevent recontamination** from exterior dirt, faeces on shells and intravalvular fluid
- Consider bivalve shellfish in **clean water:**
    - Bacteria are purged in approx. two days
    - Viruses take much longer

Types of disinfection equipment used in purification

- Ozone
- Chlorination
- UV irradiation
- Hybrid systems now also used

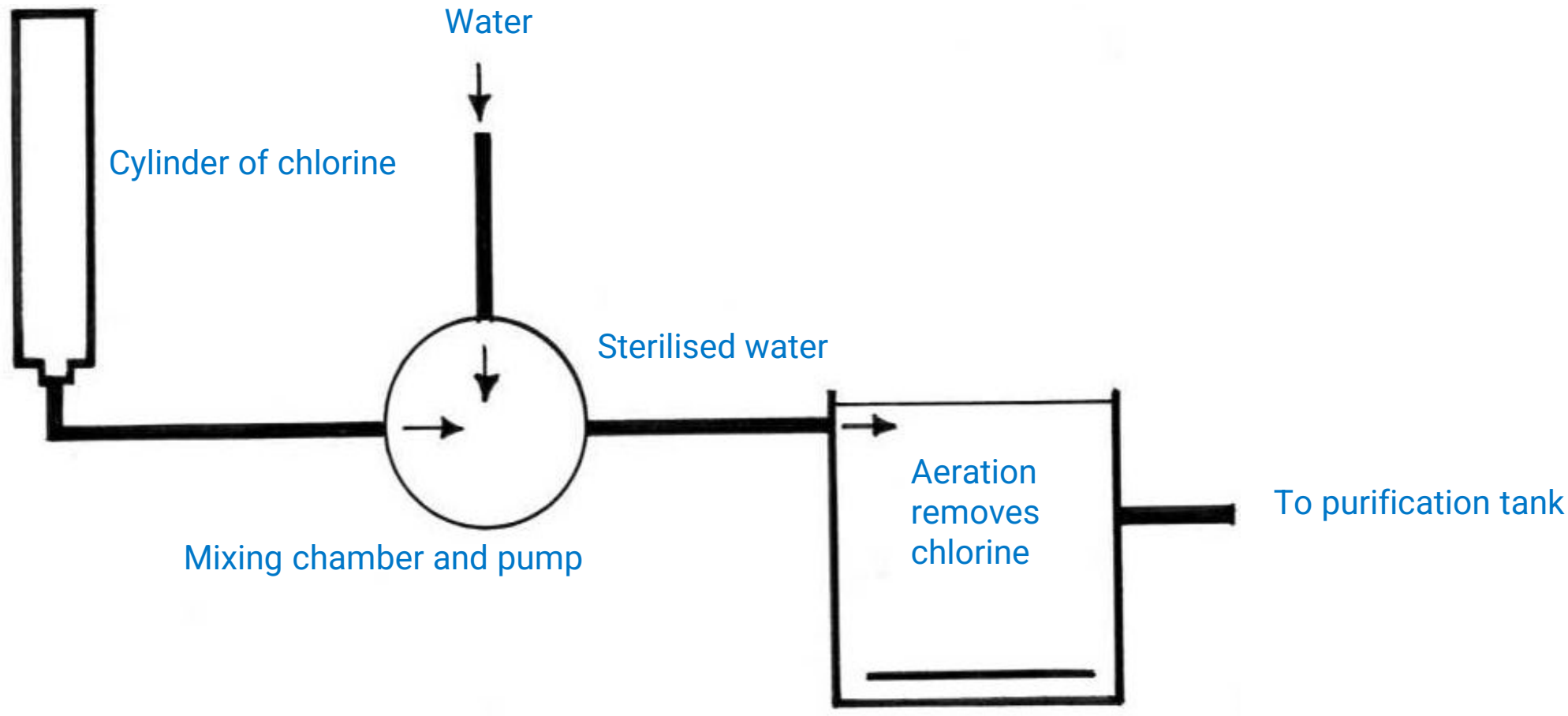
What is ozone (O_3)?

- Highly reactive form of oxygen
- Electrically generated and produced in situ
- Very unstable gas – can only be stored for 10-20 mins

- **Advantages:**
    - Powerful oxidiser - very effective biocide and disinfectant
    - Will treat turbid water
    - Increases oxygenation

- **Disadvantages:**
    - May transform bromides into bromates in seawater
    - Technically complex to implement although off-shelf solutions now available

Use of chlorine in purification



What is UV radiation?

- Germicidal light wavelength is 253.7 nm
- UV damages bacterial & viral DNA preventing replication resulting in cell death
- As water absorbs some UV, microbes are more difficult to kill in water than in air
- Commercial low-pressure mercury-vapour lamps produce a high proportion UV light

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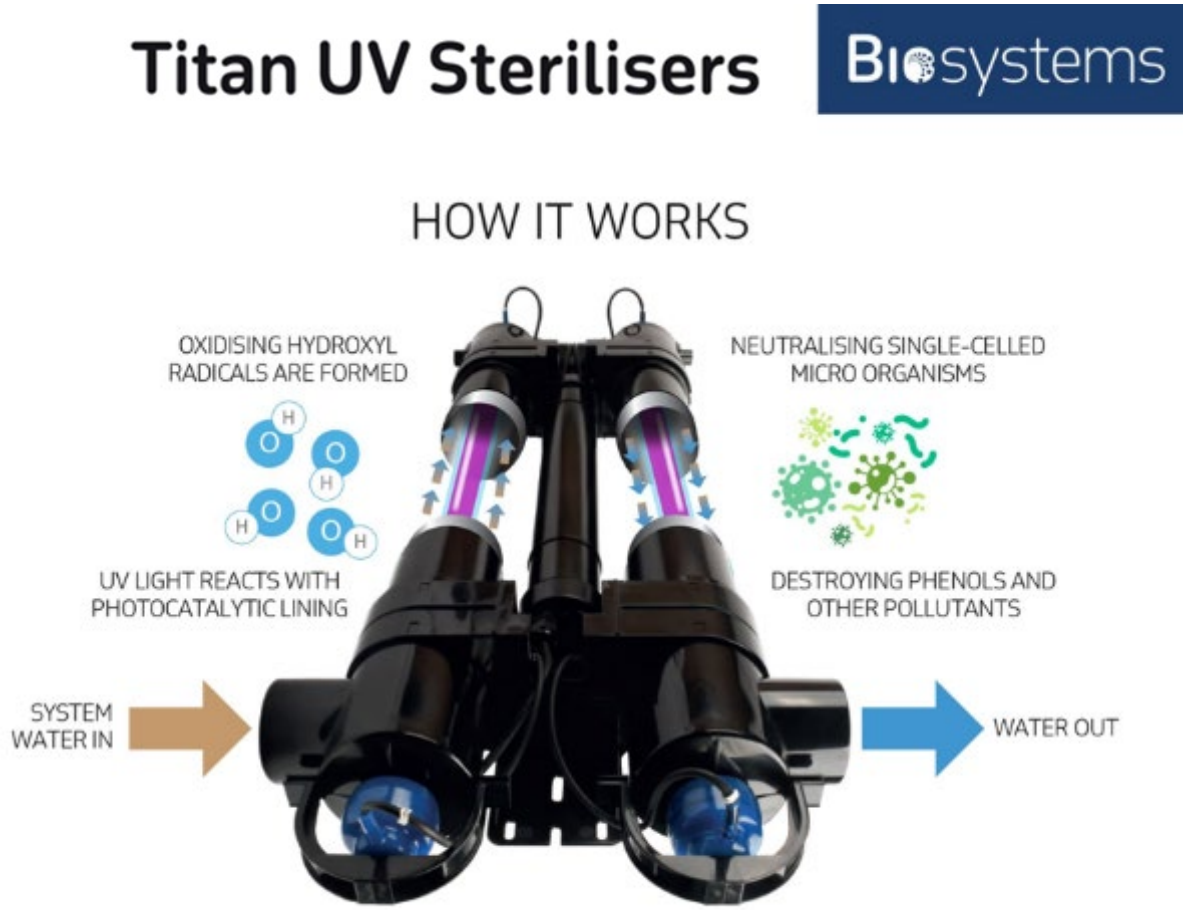
Advantages of UV radiation

- Proven technology
- Simple to implement and use
- Leaves no taint in shellfish
- Leaves no residual disinfectant
- Removes excess ozone within hybrid systems.



Main approaches to using UV systems

- **Single pass systems:**
    - Water not re-circulated, may be more affected by water supply problems
    - Operator has less control over water quality
    - **Intense** UV required to destroy bacteria and viruses
- **Recirculation systems:**
    - Many passes through UV bank and so UV can be less intense
    - Allows for **greater control** of purification conditions

UV lights

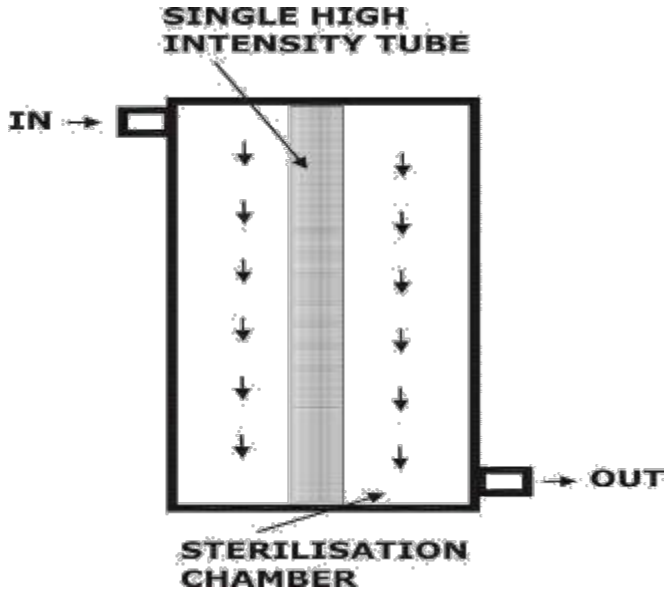
- **Wide Chamber:** single high intensity tube

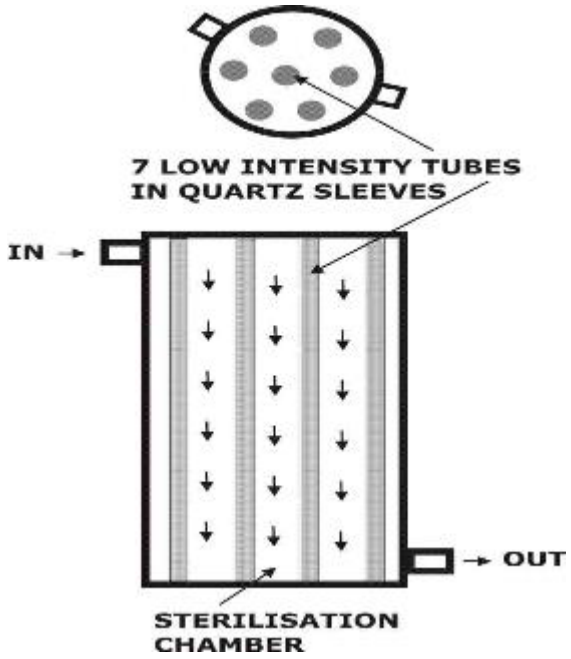
10.45 mJ/cm² @ 2,200 l/hr. = Kill 3 Log(99.9%)

- **Narrow Chamber:** multiple lower intensity tubes

5.29 mJ/cm² @ 2,200 l/hr. = Kill 2 Log (99%)

- For **clear** water only





Achieving and maintaining the correct UV dose

- **Minimum requirement:** Dose must exceed minimum prescribed for a comparable system and must not be less than **10 mJ/cm^2**

- ***Note:*** West's (1986) recommendation of using not less than 10mJ/cm^2 "*one 30w UV tube is sufficient to continuously treat 2,200L of seawater in a re-circulation system*" has been used as the basis for system approval in England and Wales since 1980's

How many UV lamps do I need?

- **Enough to be effective!**

- Check with the Seafish standard designs available on website, *or* seek expert help e.g. system or lamp suppliers

Important factors in ensuring effective UV Operation

- Age of the lamp:
    - Record lamp usage
    - Refer to manufacturer's specifications
    - Replace as part of planned maintenance
- Turbidity of the water
- Match lamp power to waterflow
- Cleanliness of the quartz sleeve
- Frequency of inspections

Seafish standard design purification systems

- **Small scale shallow tank:** 90kg mussels / 75kg oysters (125/tray)
- **Bulk bin system:** Mussels
- **Multi-layer system:** Medium / large scale
- **Vertical stack** system
- General ops manual for **non-standard** design:
  - **Installation:** LA site visit, technical inspection and bacteriological challenge testing
  - **Advantage:** Operating parameters are known and proven i.e. predictable and so less time and cost in obtaining approval

Shallow tank system

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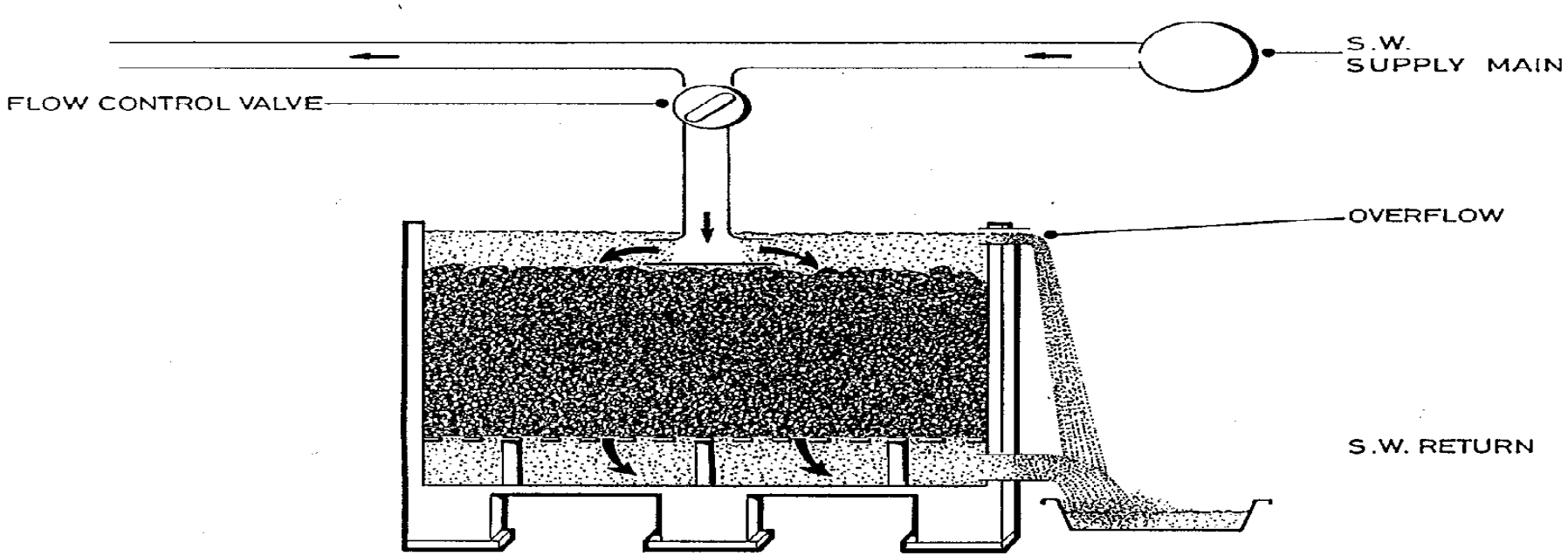
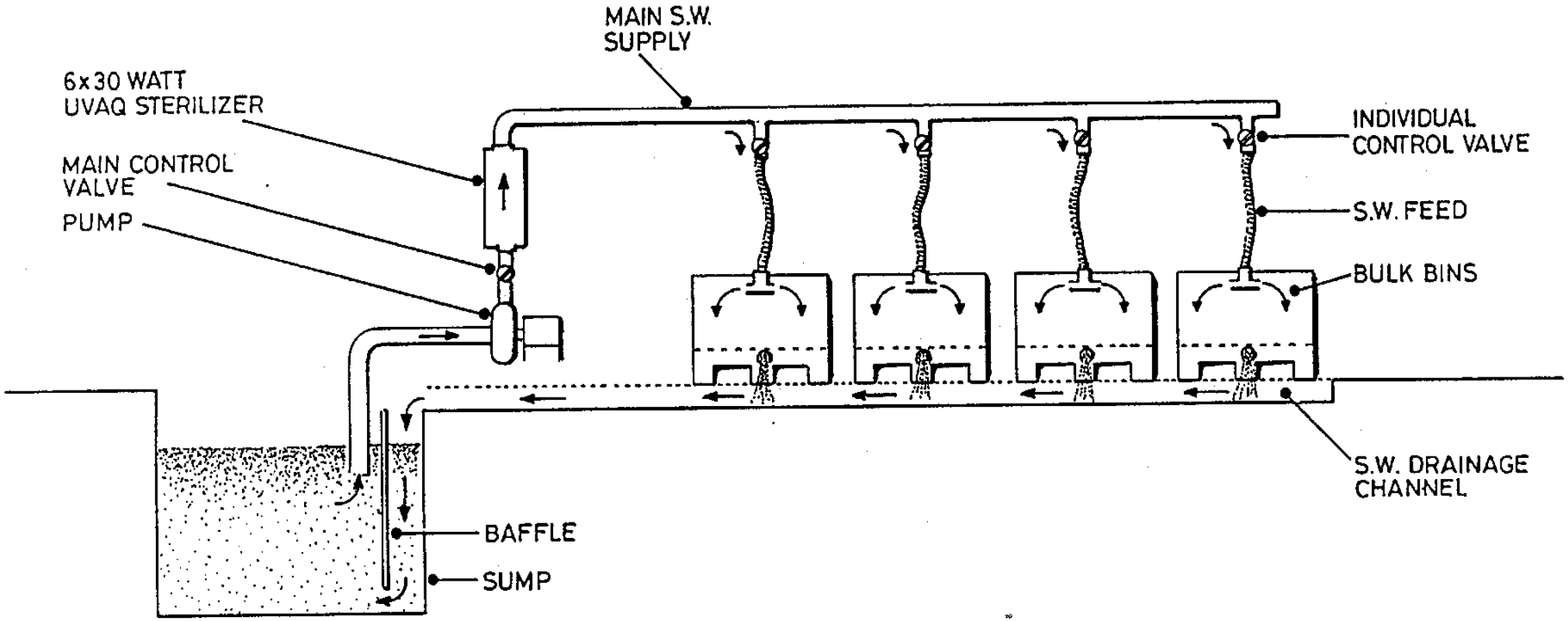
Bulk bin system



- 300-350kg bottom grown mussels vs. 250-300kg rope grown
- Potential for low Dissolved Oxygen in centre of bin
- Downwelling removes pseudofaeces

Bulk bin installation



Bulk bin system

- Flow 6,500 l/hr. = >**5 mg/litre**
- 300kg Mussels (only!)
- 32mm outlet aperture
- Down welling carries detritus to the base of container
- Sump allows settlement of detritus carried over side
- Water enters below the surface – minimises disturbance

If you want to know that you are getting 6,500+ litres into a tank per hour…

32mm diameter hole = 6,500 litres

- Q = C (Pi D2/4) (2gH)*0.5:
  - Q = flow required
  - C = non dimensional coefficient
  - D = Orifice diameter
  - g = gravitational constant
  - H = head

So – if a 32mm outlet is emptying at full-bore and the overflow is just running then you have 6,500L per hour!

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Bulk bin system

Medium scale multi-layer system

Vertical stack system

- Stack system allows single tray removal – useful for small to medium sized producers - also useful for storage after depuration.

Multi-layer system – non-standard design

Note the hazardous chemicals next to tank.

Is cleanliness of tank exterior an issue?

Bivalve shellfish handling

Know your bivalve shellfish

- You need to know the species for the ID mark
- Understand its biology e.g. subtidal *Ensis* must be re-immersed within 6 hrs. / start depuration within 24 hrs. post harvest

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Bivalve shellfish loading density

- Based on evidence that shows the buffering effect of the seawater on likely ammonia levels plus DO levels
- Examples:
    - Mussels & Cockles – 50kg/m²
    - Hard Clams (Mercenaria mercenaria) – 70kg/m² (shellfish depth generally 80mm)
    - Oysters – 530 animals/m²
    - Razor clams – 50kg/m² (bundles of ~12)

Density, examples of other considerations

- Min. height above each layer of bivalve shellfish:
    - Hard clams & oysters = 30mm
    - Mussels = 80mm (shallow tray)
- Small scale shallow tank system tray stacking:
    - 3 layers of oysters, mussels & cockles - total of 6 trays per tank
    - 2 layers hard clams - total of 4 trays per tank
    - 1 layer of razor clams - total of 2 trays per tank

Density/loading – other considerations

- Allow expansion and movement of bivalve shellfish
- Consider total loading of system
- Settlement of detritus must be possible so that it can be removed
- **Single** bivalve shellfish species only per depuration tank/system

Re-use of seawater

- **Examples:**

- **Artificial seawater** (large scale tanks):

  6 litres water :1 kg bivalve shellfish + 10% make-up = **4 weeks** normal life of that water batch.

- **Natural seawater:**

  Normally **2 weeks** unless adverse weather conditions when **4 weeks** for small scale systems.

- **High density** (medium scale tanks):

  3 litres water : 1kg bivalve shellfish + 5% = **3 cycles** life of that water batch max.

- **Visual and olfactory checks!** foam, bivalve shellfish action, no smell of NH_3.

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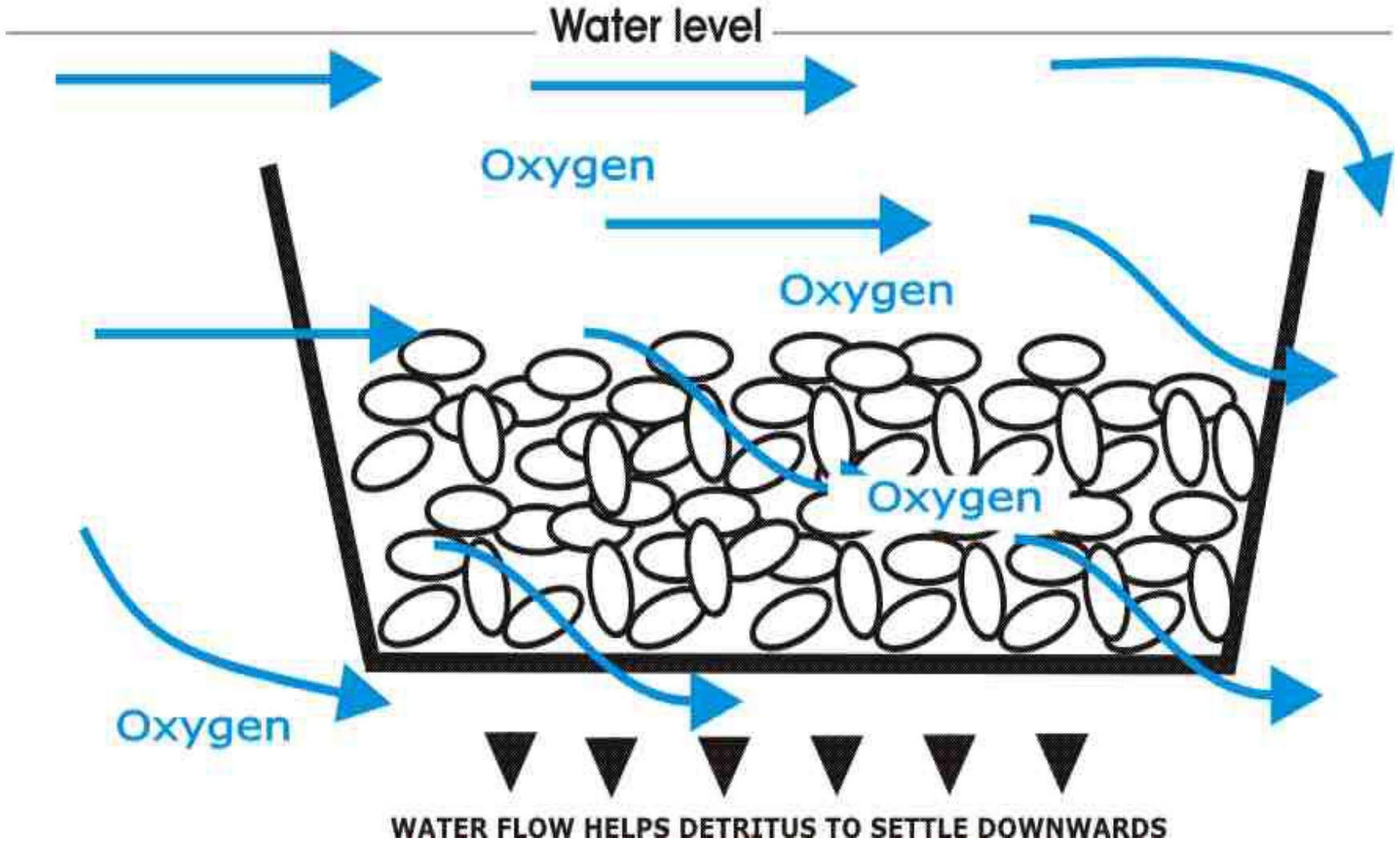
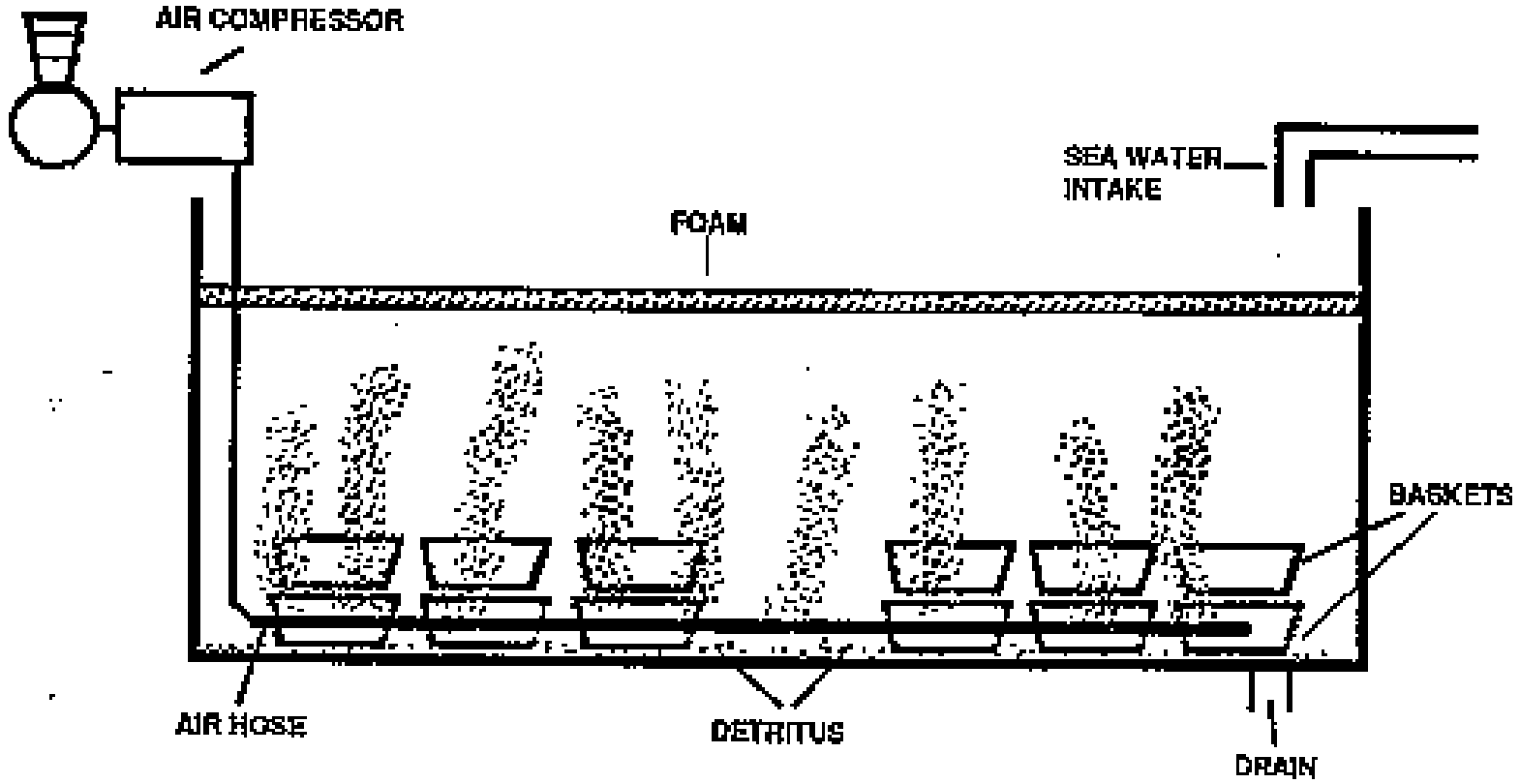
Water flow rate examples

- Typically, 20L/1kg/hr. for mussels @ 15°C.
- 2L/1kg/hr. for oysters @ 21°C.
- Bulk bin system; 108L per min. = 6,500L per hr.
- STS; 20L per min. = 1,200L per hr.

Ideal oxygen supply

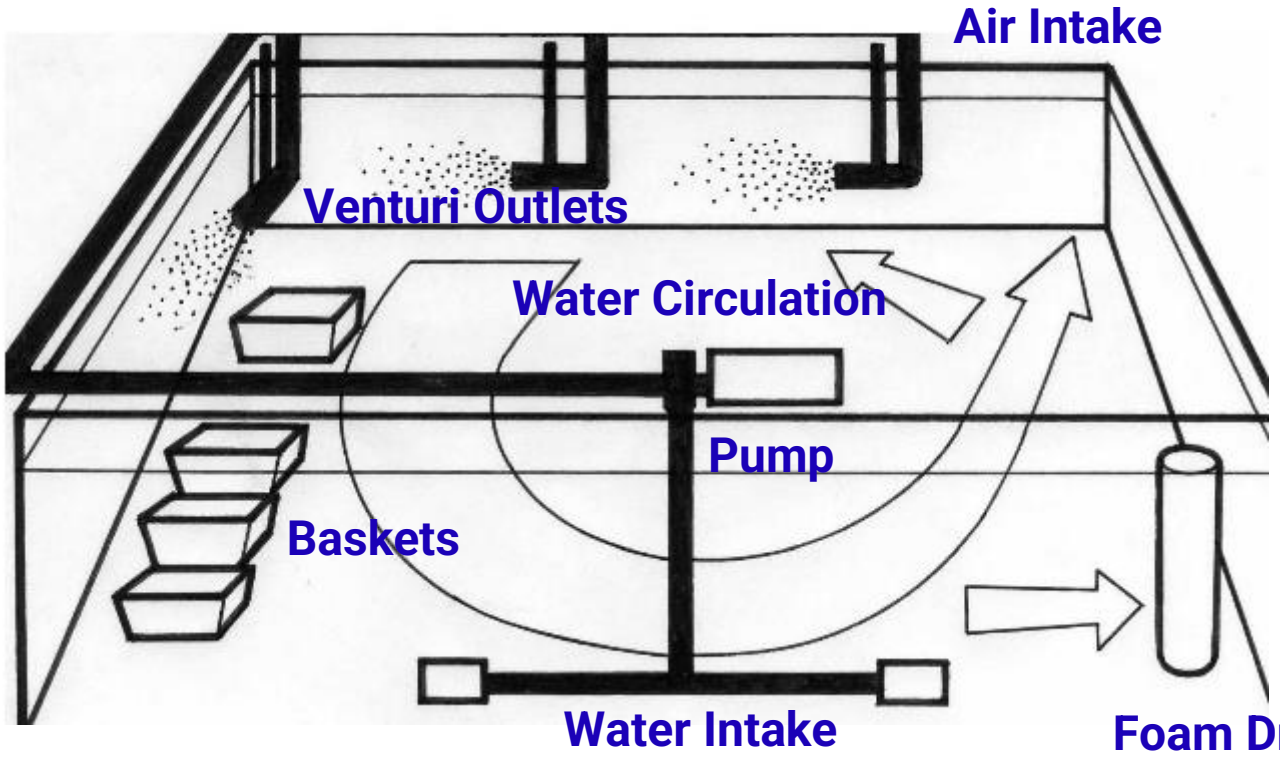


Purification tank with bubble aeration



What are the flaws in this design?

Air supplied via water intake



What are the flaws in this design?

[Venturis video]

Venturi

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Bivalve shellfish handling

- Proper planning prevents poor performance of the bivalve shellfish

- How do we get them ready?

    - Identify and check batch identity
    - Inspect / grade / clean
    - Weigh and place in containers
    - Check tanks are clean and ready
    - Label tanks with the date and time that depuration will finish

- Trays of mussels loaded and waiting to be depurated in a multi-layer system
- Clean mussels and lack of debris on tank floor - show not yet purified
- Mussels need to be rinsed after tank drain down

Effects of origin or culture method

Image: Offshore Shellfish Ltd.

- **Example - Intertidal Mussels vs rope-grown**
  - Shelf-life - due to differences in environment, intertidal mussels may have ~4 days longer shelf-life

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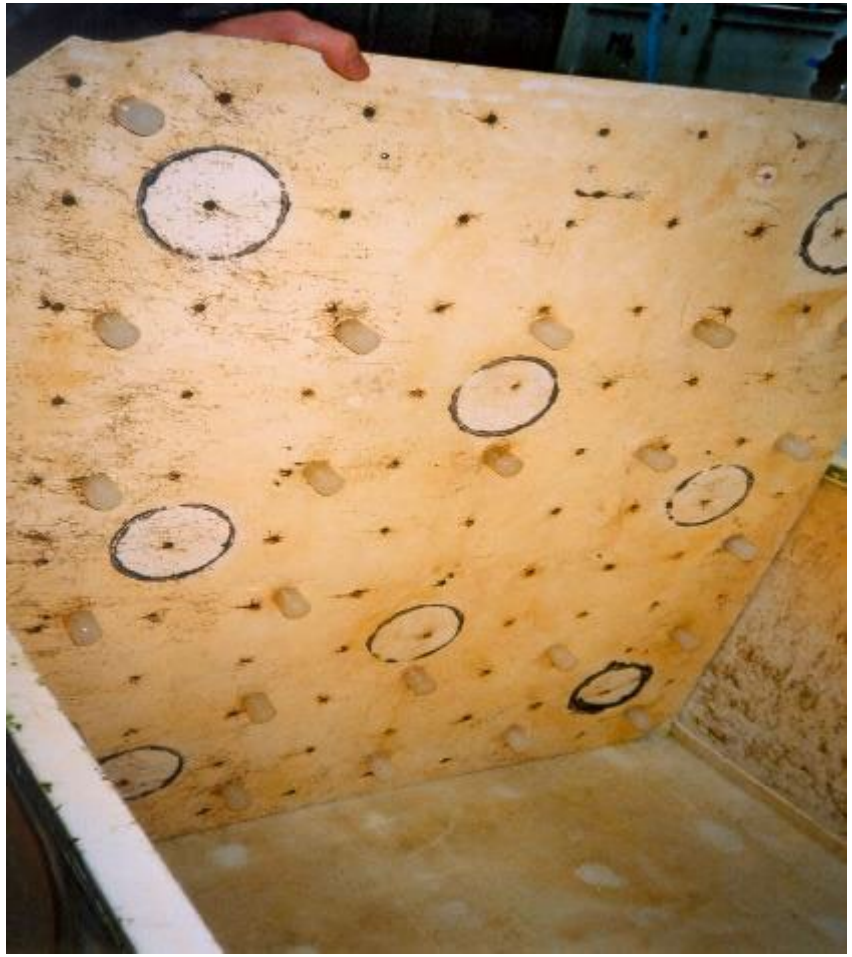
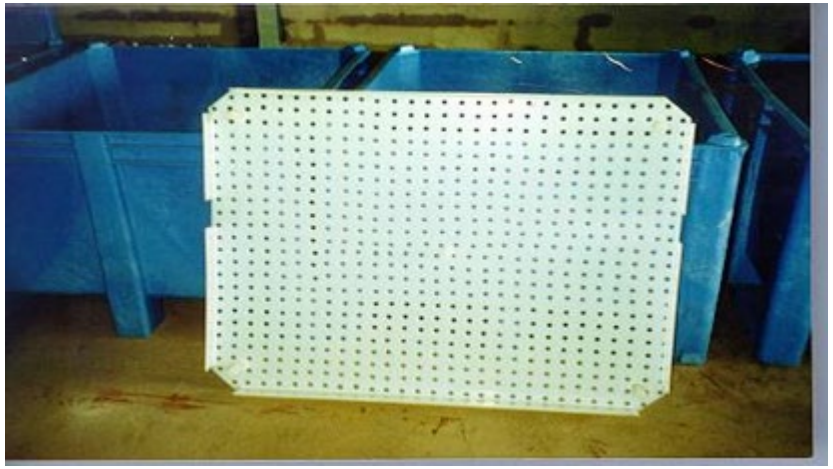
- **Example - Rope vs. Bottom cultured Mussels:**
  - Ability to withstand rough handling – bottom cultured mussels have thicker shells and so can withstand robust handling
  - Purification tank loading density for bottom cultured mussels is also greater than rope grown Mussels.

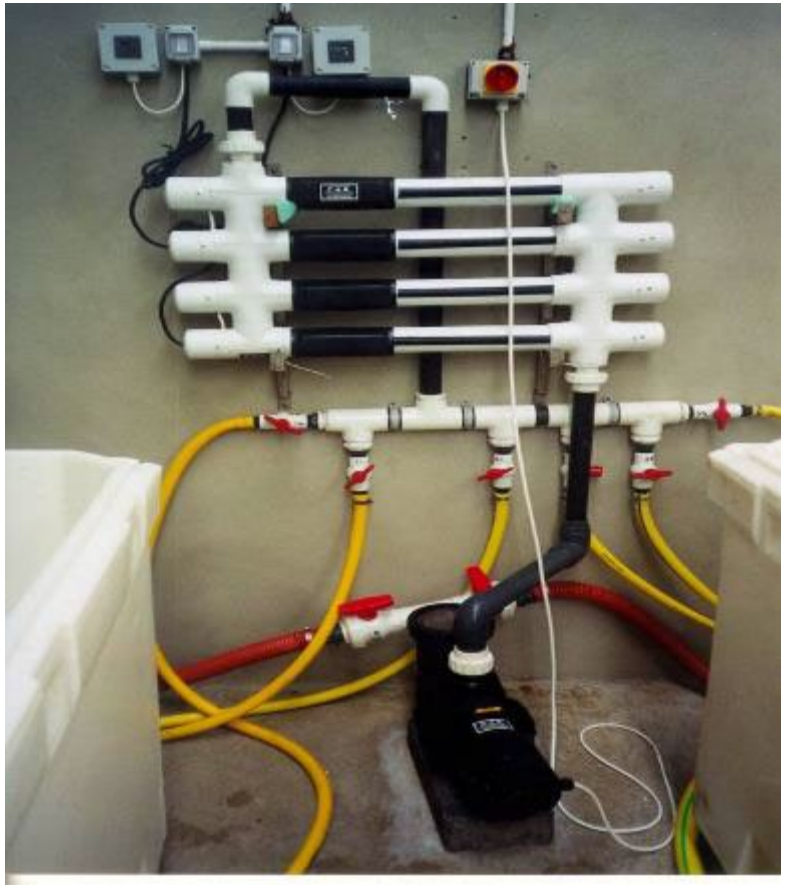
Post purification treatment

- Tank drain slowly and completely
- Lift animals out – **avoid resuspension of detritus!**
- Wash - how?
- Inspect
- De-clump if needed*
- Weigh and bag up
- Label
- Store / despatch
- Clean tanks and other equipment

Keeping the Mussels out of the detritus and byssus thread cleaning

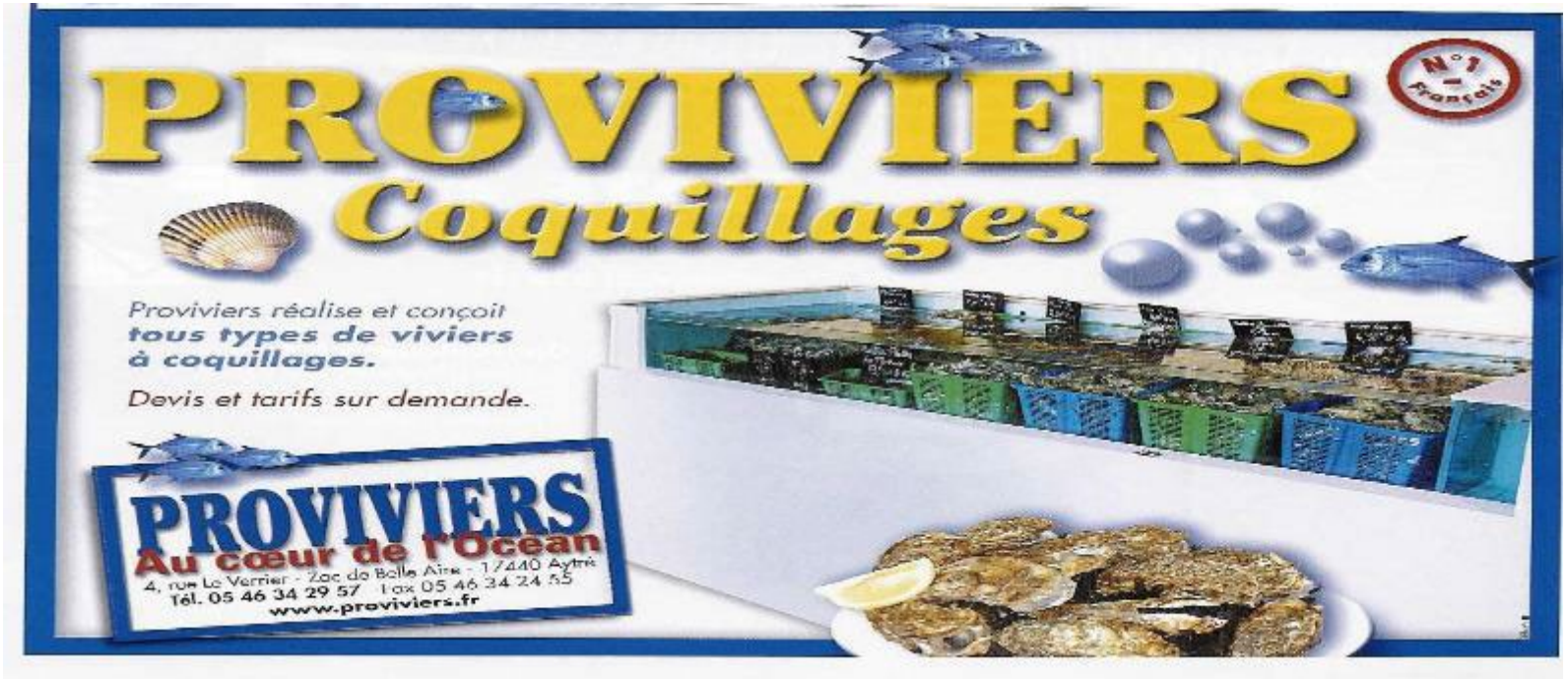






- Catch basket in pump required cleaning and so was a potential source of contamination

- Difficult to check UV operation on this system



“Conditioning may only be carried out in approved dispatch/purification centres. Re-immersion of live bivalve molluscs [*bivalve shellfish*] for human consumption in display or storage tanks, e.g. in a retail establishment, **is not permitted**.” - FSA

Bivalve shellfish handling

Do this:

- Inspect and grade
- Remove duds, mud balls etc
- Handle gently
- Protect from heat

Do not do this!

- Mix batches
- Have dead or different animals in tanks
- Throw or clump
- Stand in sun
- Expose to contamination

seafish

Stressed bivalve shellfish

- What causes stress to bivalve shellfish?
    - Low dissolved oxygen levels
    - Temperature or salinity outside of range
    - Rough handling before, during or after purification
    - Other shocks
- Stressed bivalve shellfish will:
    - **Fail to depurate**
    - Have reduced shelf life
    - May even die in the tank

How do we know it's working?

- **It's working if…**
    - The **bivalve shellfish open their shells**
    - Moderate foam appears on top
    - The lamps are on
    - Lots of water is passing through the system
- **It's not working if ….**
    - The bivalve shellfish **don't** open their shells
    - You disturb or handle them when they are in the tanks
    - You place more bivalve shellfish in the tank after the start time

seafish

Sources of guidance and support

Organisations and support

- FSA Delivery Team
- Sea Fish Industry Authority:

  Seafish guidance on delivering safer bivalves to market

  Training courses:

  Bivalve Purification Management

  Food Authenticity and Integrity Verification

  Food Safety and HACCP Programmes

- Your local Environmental Health Officer should also be contacted for all matters concerning food safety and HACCP

Any questions?

- Post-course support
- Thank you!

Online exam

- Multiple choice - 20 questions - closed book
- **Exam questions are based on a 42 hour purification cycle**
- Only one answer is correct for each question
- Answer **EVERY** question – even if you have to guess
- 75% pass mark

Thank you

Optional contact details

Optional contact details

Here to give the UK seafood sector **the support it needs to thrive.**