

# Unit 29: Understanding Aquaculture Systems

<b>Unit code:</b>	<b>L/601/2116</b>
<b>QCF Level 3:</b>	<b>BTEC National</b>
<b>Credit value:</b>	<b>10</b>
<b>Guided learning hours:</b>	<b>60</b>

## ● Aim and purpose

This unit aims to introduce learners to aquaculture system skills and understanding and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or on to further/higher education.

## ● Unit introduction

The production of fish for food consumption is an increasingly important industry in relation to production of food for human consumption in general. As the output and demand for fish from capture fisheries decreases, the importance of fish produced in aquaculture facilities is likely to increase. However, there are many concerns over the systems used to produce fish from aquaculture, in particular that it is not sustainable and may actively harm the environment. In the light of these conflicting issues the need for well-designed aquaculture systems and good aquaculture husbandry has never been more important. Understanding the industry, the various systems that can be used, and the management techniques available, is vital for anyone looking to work within the industry.

The first part of this unit looks at the principles of the common aquaculture systems. This will include looking at the global aquaculture industries and the use, advantages and disadvantages of these systems. This will include freshwater and marine aquaculture species, including fish and shellfish. Learners will use this knowledge to investigate the environmental implications of aquaculture systems as well as the new technologies and management strategies that are being introduced to improve the situation.

The second part of the unit is more practically based and will look at the requirements for planning and designing aquaculture systems. Learners will mainly cover fish production but other farmed species may also be included. Health and safety, animal welfare and environmental issues will be an essential part of the delivery of this section. Finally, learners will cover the maintenance and management requirements of various aquaculture systems. This will include the generic husbandry skills required to manage aquaculture systems.

## ● Learning outcomes

**On completion of this unit a learner should:**

- 1 Understand principles of aquaculture systems
- 2 Understand the environmental implications of aquaculture systems
- 3 Be able to plan and design fish production units
- 4 Understand management operations.

# Unit content

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## 1 Understand principles of aquaculture systems

*Principles of aquaculture systems:* the major UK and global aquaculture industries (development, species to include freshwater and marine, production, employment, allied industries, constraints, current issues); definition of intensive, extensive, semi-intensive, ranching, open-water stocking, polyculture, land-based farms, off-shore units in relation to aquaculture; uses, advantages and disadvantages of commonly used aquaculture production units, eg earth ponds, tanks, raceways, cages, flow-through and recirculation, shellfish rafts and bags; related systems, site selection, equipment, staffing, water quantity and quality requirements; related environmental and animal welfare issues; health and safety.

## 2 Understand the environmental implications of aquaculture systems

*Environmental implication of aquaculture systems:* sources and formulation of artificial fish food; land use; water use; species used; fish-farm escapes; disease and pathogen issues; pest and predator control; chemical treatments; animal welfare issues.

*Environmental benefits:* rural employment; land and water use; food source

*Industry and legislative compliance:* industry codes of practice; new technology; developments in feed formulations; legislative control.

## 3 Be able to plan and design fish production units

*Planning and designing fish production units:* requirements of specific production units, eg location, dimensions, types and construction requirements, water sources, quantity and quality, topography, soil-type, drainage considerations, access, tidal flows and currents, fetch, depth, substrate type, exposure, security, services, communications; methods of acquiring site, eg land agreements, leasing and licensing procedures, share-farming, contract-farming, partnerships, purchasing, planning permission; reasons for choice of fish production units, eg site factors, species factors, water factors, soil type; methods used to design a fish production unit, eg basic surveying techniques, computer-aided design (CAD) showing component parts of the unit; effluent treatment methods, eg gravitational separation, sedimentation, settlement lagoons, bio-filters, screens, disinfection; relevant current legislation, eg Environment Act 1995, Town and Country Planning Act 1990, Aquatic Animal Health Act 2008

## 4 Understand management operations

*Management operations:* pond maintenance and preparation operations, eg drainage, bank maintenance, organic and inorganic fertilisation, food chains, rotifer counts, timing of stocking; general management operations, eg disinfection, aeration, filling and topping-up; stocking procedures to include water management, natural stocking density; feeding regimes and methods; sampling and monitoring growth rates; health checking; weed control; grading; harvesting; pest and predator control, eg species, predator netting, rodent control; security systems; health and safety; animal welfare; relevant current legislation

## Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade, the evidence must show that the learner is able to:	To achieve a merit grade, the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade, the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<b>P1</b> explain the suitability of a species for aquaculture [CT]	<b>M1</b> explain all the site requirements for a selected aquaculture production facility to produce a named species	<b>D1</b> analyse how current major threats and opportunities in cyprinid fish farming may influence plans for the development of an aquaculture production facility
<b>P2</b> explain the different types of aquaculture systems		
<b>P3</b> explain the environmental impact of a given aquaculture facility		
<b>P4</b> discuss the use of pest control on the environment		
<b>P5</b> explain the legal implications for a given aquaculture facility		
<b>P6</b> plan an aquaculture system for a given aquatic species [CT]	<b>M3</b> carry out a site survey on a given piece of land and assess its suitability for a given aquaculture system	<b>D2</b> assess the efficiency of a described aquaculture system for a given species of fish, and suggest appropriate improvements.
<b>P7</b> design a system to treat effluent from a given aquaculture system [IE]		
<b>P8</b> Produce risk assessments for a given aquaculture system [EP]		
<b>P9</b> explain the basic pre-stocking maintenance for a given aquaculture facility	<b>M4</b> explain the function and maintenance requirements of the key parts of a selected recirculation system.	
<b>P10</b> explain the maintenance routines for a given aquaculture facility		
<b>P11</b> explain security issues for a given aquaculture facility.		

**PLTS:** This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

<b>Key</b>	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

# Essential guidance for tutors

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## Delivery

Delivery of this unit will involve practical assessments, written assessment, visits to suitable aquaculture systems and possibly link to work-experience placements. Tutors delivering this unit have opportunities to use as wide a range of techniques as possible. Lectures, discussions, seminar presentations, site visits, supervised aquacultural practicals, research using the internet and library resources and the use of personal and industrial experience would all be suitable.

Work placements should be monitored and it would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities are undertaken so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to work with recirculation systems and they should ask for observation records or witness statements to be provided as evidence of this.

Visiting expert speakers could add to the relevance of the subject for learners. For example, a fish farm manager, construction engineer or planning officer could talk about their work and the methods they use.

Whichever delivery methods are used, it is essential that tutors stress the importance of animal welfare, sound environmental management and the need to manage the resource using legal methods. Health and safety issues relating to working in and around water must be stressed and reinforced regularly and risk assessments must be undertaken before any practical activities or visits to fish farms. Adequate personal protective equipment (PPE) must be provided and used following the production of suitable risk assessments.

Learning outcome 1 is likely to be delivered through formal lectures, discussion, supervised site visits and independent learner research. Learners will become aware of the development, potential, current status and global standing of the aquacultural industries in order to understand the main principles currently used in aquaculture systems. The most commonly used systems will be looked at in detail.

Learning outcome 2 covers the main environmental implications of aquaculture systems. This is likely to be delivered through formal lectures, discussions and independent learner research. Visiting speakers and site visits will add relevance to delivery. Learners will study the current implications of aspects of aquaculture systems as well as the benefits. They will then look at the industry and legislative efforts to reduce and improve the environmental performance of the industry.

Learning outcome 3 covers the principles of planning and designing fish production units. Delivery techniques should be varied but it is expected that formal lectures, discussions and supervised site visits would form part of the delivery. Learners will cover the requirements of specific systems before moving on to site acquisition and site-specific requirements. This will lead on to the more practical aspects of surveying and planning site details.

The final learning outcome covers the management operations involved in fish production. This is more practically based and covers specific management operations as well as more general operations. Delivery techniques should be varied but it is expected that formal lectures, discussions and supervised site visits would form part of the delivery. This learning outcome would also benefit from supervised practical activities.

## Outline learning plan

The outline learning plan has been included in this unit as guidance, and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives an indication of the volume of learning it would take the average learner to achieve the learning outcomes. It is indicative and is one way of achieving the credit value.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Principles of aquaculture systems and industry.
Types of aquaculture systems available and in use.
Site selection and related environmental, health and safety issues and animal welfare.
<b>Assignment 1: Planning an Aquaculture System</b> (P1, P2, M1, D1)
Introduction to assignment.
Environmental implications.
Environmental benefits.
Industry and legislative issues related to environmental compliance.
<b>Assignment 2: Environmental Concerns</b> (P3, P4, P5, M2)
Introduction to assignment.
Planning: process and tools.
Site requirements.
Site acquisition.
Site survey (practical and theory).
Legislative framework for planning.
Effluent treatment methods.
<b>Assignment 3: Planning</b> (P6, P7, P8, M3, D2)
Introduction to assignment.
Management operations – planning.
Specific tasks.
Generic tasks.
Health and safety legislation.
<b>Assignment 4: Management Activities</b> (P9, P10, P11, M4)
Introduction to assignment.
Security reasons and solutions.
Unit review.

## Assessment

For P1, learners must explain the suitability of a species for aquaculture. Learners will be expected to cover a full range of factors that make a species of fish suitable for aquaculture, including relevant examples. Evidence could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or written assignment.

P2 requires learners to explain the different types of aquaculture systems. Learners will be expected to describe and explain a full range of relevant aquaculture systems. Evidence could be in the same form as for P1.

For P3, learners are required to explain the environmental impact of a given aquaculture facility. Tutors should identify the specified aquaculture facility through discussion with learners. Learners will be expected to cover all the main potential impacts. Evidence could be in the same form as for P1.

For P4, requires learners to discuss the impact of pest control on the environment. Learners will be expected to cover the main pest, including pathogen, control methods and discuss the possible environmental consequences of each. Evidence could be in the same form as for P1.

P5 requires learners to explain the legal requirements for a given aquaculture system. Tutors should agree the given aquaculture system in discussion with learners. Learners will be expected to cover the full range of legal implications and give a reasoned explanation of each area. Evidence could be in the same form as for P1.

P6 requires learners to plan an aquaculture system for a given aquatic species. Tutors should agree the aquatic species in discussion with learners. The plans should include diagrams and explanations of the facility. Evidence is likely to be in the form of a set of plans and written report but could be a presentation.

For P7, learners are required to design a system to treat effluent from a given aquaculture system. Tutors should agree the given aquaculture system in discussion with learners. Evidence could be in the same format as for P1.

P8 requires learners to produce risk assessments for a given aquaculture system. Tutors should agree the given aquaculture system in discussion with learners. The format should be appropriate for the task and use relevant health and safety sheets. Evidence is likely therefore to be appropriate completed forms.

For P9, learners are required to explain the pre-stocking maintenance for a given aquaculture facility. Tutors should agree the given aquaculture facility in discussion with learners. Learners should cover the full range of maintenance including equipment and facilities, as well as any water conditioning.

P10 requires learners to explain the maintenance routines for a given aquaculture facility. Tutors should agree the given aquaculture system in discussion with learners. Learners should cover daily, weekly and annual maintenance tasks. The evidence could be presented in the form of a work diary, report or presentation.

P11 requires learners to explain the security issues for a given aquaculture facility. Tutors should agree the given aquaculture system in discussion with learners. Evidence could be in the same form as for P1.

For many of the tasks, the aquaculture facilities or systems must be agreed in discussion with learners. This will allow learners to investigate areas of particular interest. However, every effort should be made to ensure that where possible, to ensure assessment is fair, the size and complexity of these should be the same for all learners.

For M1, learners must explain the site requirements for selected aquaculture production units to produce a named species. Tutors should identify the aquaculture production units and species, or agree them through discussion with learners. It is expected that, as a minimum, learners will provide evidence covering at least two different aquaculture systems. Evidence could be in the same form as for P1.

For M2, learners are required to explain the methods used to address the potential environmental impacts of a given aquaculture system. Tutors should agree the given aquaculture system in discussion with learners. Learners will be expected to cover all the main potential impacts and the methods used to address each one. Evidence is likely to be linked to P3 and could be presented in the same format.

M3 requires learners to carry out a site survey on a given piece of land and assess its suitability for a given aquaculture system. Learners must have access to an appropriate piece of land in order to complete the practical aspects of the task. Evidence is likely to be a presentation or report.

M4 requires learners to explain the function and maintenance requirements of the key parts of a selected recirculation system. The selected recirculation system should be agreed in discussion with learners. The explanation must include all the main equipment used in the system. Evidence is likely to be in the same form as for P1.

For D1, learners are required to analyse how current major threats and opportunities in cyprinid farming may influence plans for the development of a cyprinid fish farm. Evidence should be wide-ranging and realistic. Learners can concentrate on one particular area of aquaculture, but all areas must be covered. Evidence is likely to be a report or presentation.

D2 requires learners to assess the efficiency of a described aquaculture system for a given species of fish and suggest appropriate improvements. The aquaculture system should be agreed in discussion with learners. Evidence should be wide-ranging and realistic, and suggestions must be practicable.

## Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1, D1	Planning an Aquaculture System	<p>Your task is to plan an aquaculture system for a specified situation.</p> <p>Firstly you must explain the types of aquaculture systems that are available and what makes different fish species suitable for use in aquaculture.</p> <p>The site must suit the system so you must explain site requirements for a selected aquaculture production facility. The final part of this planning process is to assess current threats and opportunities and discuss how these will influence the plans.</p>	Presentation and report
P3, P4, P5, M2	Environmental Concerns	<p>One of the key issues associated with aquaculture is environmental concerns. You must explain the environmental impact of a given aquaculture facility including the pest-control methods that it may use and their environmental impacts.</p> <p>What are the legal requirements for this aquaculture facility?</p> <p>Explain what methods the farm may use to address its potential environmental impact.</p>	Report
P6, P7, P8, M3	Planning	<p>Using the information gained in Assignment 1, plan an aquaculture system for a given aquatic species, including the full design for the treatment of effluent from the farm. The plan must include a full site risk assessment.</p> <p>Using this plan, select a site and complete a site survey and assess its suitability for the planned development.</p> <p>During a visit to a production system analyse it against your design criteria and assess the efficiency of the system. What methods of improvement can you see and how may they affect the design of your own system.</p>	Report
P9, P10, P11, M4	Management Activities	<p>The facility you designed has finally been built. For the aquaculture facility, explain the pre-stocking maintenance required for the unit. Once stocked, complete a maintenance routine chart for employees. Explain the security issues that apply to the site and how these would be covered.</p> <p>Assume that the unit requires a recirculation system. Explain the function of each of the key parts and show how the maintenance would be fitted into the routine completed above.</p>	Report and management plan

## Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
Introduction to Aquatic Ecology	Understanding Water Quality
	Undertake and Review Work-related Experience in the Land-based Industries

### Essential resources

Learners will need access to aquaculture systems capable of rearing a range of species using a variety of equipment and holding units. They will also require organised visits to a variety of aquaculture facilities.

Tutors delivering this unit should be competent and experienced in aquaculture practices.

### Employer engagement and vocational contexts

This unit focuses on understanding the aquaculture industry. Learners should be encouraged to develop this knowledge during work-experience placements. Guest lectures and off-site visits should also be used to highlight how this knowledge and these skills are important within the industry.

### Indicative reading for learners

#### Textbooks

- Beveridge M — Cage Aquaculture, 3rd Edition (Fishing News Books, 2004) ISBN 1405108428
- Boyd C — Water Quality Management for Pond Fish Culture (Elsevier, 1982) ISBN 0444420541
- Bromage N and Roberts R — Broodstock Management and Egg and Larval Quality (Blackwell Science, 1994) ISBN 0632035919
- Billard R — Aquaculture of Cyprinids (INRA, 1994) ISBN 2853407918
- Billard R — Carp: Biology and Culture (Springer-Verlag, 1999) ISBN 1852331186
- Egna H and Boyd C — Dynamics of Pond Aquaculture (Lewis Publishers US, 1997) ISBN 1566702747
- Heen K, Monahan R and Utter F — Salmon Aquaculture (Blackwell Science, 1993) ISBN 0852382049
- Girdler A, Welcomme R and Wellby I — Freshwater Fisheries Management (Blackwell Publishing, 2010) ISBN 1405133325
- Horvath L, Tamas G and Seagrave C — Carp and Pond Fish Culture, 2nd Edition (Blackwell Science, 2002) ISBN 0852382820
- Huet M — Textbook of Fish Culture: Breeding and Cultivation of Fish, 2nd Edition (Blackwell Science, 1994) ISBN 0852382197
- Jhingran V and Pullin R — A Hatchery Manual for the Common, Chinese and Indian Major Carp (International Specialized Book Service, 1988) ISBN 9711022176
- Laird L and Needham T — Salmon and Trout Farming (Ellis Horwood, 1994) ISBN 0137883242

Lavens P and Sorgeloos P — Manual on the Production and Use of Live Food for Aquaculture (FAO of the UN, 1997) ISBN 9251039348

Lucas J and Southgate P — Aquaculture: Fish and Shellfish Farming (Blackwell Science, 2003) ISBN 0852382227

Roberts R and Shepherd C — Handbook of Trout and Salmon Diseases, 3rd Edition (Blackwell Science, 1997) ISBN 0852382448

Pillay T and Kutty M — Aquaculture: Principles and Practices (Blackwell Publishing, 2005) ISBN 1405105321

Sedgwick S — Salmon Farming Handbook (Blackwell Science, 1989) ISBN 0852381581

Sedgwick S — Trout Farming Handbook, 6th Edition (Blackwell Science, 1995) ISBN 0852382324

Shepherd C and Bromage N — Intensive Fish Farming (Blackwell Science, 1992) ISBN 063203467X

Stickney R — Aquaculture: An Introductory Text (CABI Publishing, 2005) ISBN 0851990819

Wedemeyer G — Fish Hatchery Management, 2nd Edition (CABI Publishing, 2002) ISBN 0851996272

Willoughby S — Manual of Salmonid Farming (Blackwell Science, 1999) ISBN 0852382456

### **Journals**

*Aquaculture International*

*Fish Farmer*

*Fish Farming International*

*Journal of World Aquaculture Society*

*Progressive Fish Culturist*

## Websites

<a href="http://www.aquaculture.stir.ac.uk">www.aquaculture.stir.ac.uk</a>	Aquaculture
<a href="http://www.ag.arizona.edu/azaqua">www.ag.arizona.edu/azaqua</a>	Arizona Aquaculture
<a href="http://www.aquanet.com">www.aquanet.com</a>	Aquatic Network
<a href="http://www.aquanic.org">www.aquanic.org</a>	Aquatic Network Information Centre
<a href="http://www.britishtROUT.co.uk">www.britishtROUT.co.uk</a>	British Trout Association
<a href="http://www.cefas.co.uk">www.cefas.co.uk</a>	Centre for Environment, Fisheries and Aquaculture Science
<a href="http://www.defra.gov.uk">www.defra.gov.uk</a>	Department for Environment, Food and Rural Affairs
<a href="http://www.enaca.org">www.enaca.org</a>	Institute of Marine Finfish Aquaculture Network
<a href="http://www.easonline.org">www.easonline.org</a>	European Aquaculture Society
<a href="http://www.efishbusiness.co.uk">www.efishbusiness.co.uk</a>	Fisheries legislation and Business help
<a href="http://www.fao.org/fishery/en">www.fao.org/fishery/en</a>	Food and Agriculture Organisation
<a href="http://www.fish.wa.gov.au/aqua">www.fish.wa.gov.au/aqua</a>	Pearling and Aquaculture
<a href="http://www.feap.info/feap">www.feap.info/feap</a>	The Federation of European Aquaculture Producers
<a href="http://www.hse.gov.uk">www.hse.gov.uk</a>	Health and Safety Executive
<a href="http://www.lantra.co.uk">www.lantra.co.uk</a>	Sector Skills Council for the Environmental and Land-based Industries
<a href="http://www.scotland.gov.uk">www.scotland.gov.uk</a>	Scottish Executive
<a href="http://www.was.org">www.was.org</a>	The World Aquaculture Society

## Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
<b>Independent enquirers</b>	designing a system to treat effluent from a given aquaculture system
<b>Creative thinkers</b>	explaining the suitability of a species for aquaculture planning an aquaculture system for a given aquatic species
<b>Effective participators</b>	producing risk assessments for a given aquaculture system.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
<b>Creative thinkers</b>	explaining the methods used to address the potential environmental impacts of a given aquaculture system
<b>Team workers</b>	carrying out a site survey on a given piece of land and assessing its suitability for a given aquaculture system.
<b>Self-managers</b>	carrying out a site survey on a given piece of land and assessing its suitability for a given aquaculture system.
<b>Effective participators</b>	explaining the methods used to address the potential environmental impacts of a given aquaculture system.

## ● Functional Skills — Level 2

Skill	When learners are ...
<b>ICT – Find and select information</b>	
Select and use a variety of sources of information independently for a complex task	designing a system to treat effluent from a given aquaculture system planning an aquaculture system for a given aquatic species
<b>ICT – Develop, present and communicate information</b>	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> <li>• text and tables</li> <li>• images</li> <li>• numbers</li> <li>• records</li> </ul>	planning an aquaculture system for a given aquatic species
Present information in ways that are fit for purpose and audience	planning an aquaculture system for a given aquatic species
<b>English</b>	
Speaking and listening — make a range of contributions to discussions and make effective presentations in a wide range of contexts	explaining security issues for a given aquaculture facility
Reading — compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	explaining the methods used to address the potential environmental impacts of a given aquaculture system producing risk assessments for a given aquaculture system
Writing — write documents, including extended writing pieces, communicating information, ideas and opinions effectively and persuasively	planning an aquaculture system for a given aquatic species

