Unit 11: Warmwater and Marine Aquaculture

Unit code: A/600/9261

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to introduce learners to the skills and knowledge associated with warmwater and marine aquaculture and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

Unit introduction

Aquaculture is a rapidly expanding field of food production worldwide. Warmwater and marine aquaculture are easily the largest contributor to the global production of aquaculture products. This unit has a global perspective but also covers the important domestic priorities. Both forms of aquaculture represent important and growing sectors of fish production within the UK.

This unit will enable learners to study this wide ranging area of fish production and develop the knowledge and skills required to work in either warmwater or marine aquaculture in the UK or overseas.

The first part of the unit investigates the main warmwater and marine aquaculture industries, in the UK and globally. Learners will be encouraged to look at the history of the industries and the range of issues that now affect them, such as sustainability, marketing and the risks of introducing non-native species.

Learners will then move on to look at the current principles and practices used to farm warmwater fish and marine fish respectively. Learners will cover many aspects including holding units, equipment, biological requirements of the species, nutrition, biosecurity and disease.

In the final part of this unit learners will develop practical skills in the important area of producing, harvesting and use of live food. For both warmwater and marine aquaculture the use of live food is a vital part of the production process. Learners will study these areas and the various methods of production.

Learning outcomes

On completion of this unit a learner should:

1 Know warmwater and marine aquaculture industries

2 Understand the principles and practices used to farm warmwater freshwater fish

3 Understand the principles used to farm marine fish

4 Be able to produce live food for warmwater and marine aquaculture.

Unit content

1 Know the warmwater and marine aquaculture industries

Warmwater and marine aquaculture industries: development of warmwater and marine aquaculture industries globally; major species farmed and the factors which make them suitable for farming; issues of sustainable development both economically and environmentally; comparison of production from aquaculture with wild capture fisheries; existing markets for farmed warmwater and marine species and potential markets and competitors for these species; development of warmwater and marine aquaculture in the UK; limitations to the growth of the warmwater and marine aquaculture industries in the UK; potential risks of farming non-native fish specieseg market development, escapees, diseases

2 Understand the principles and practices used to farm warmwater freshwater fish

Principles and practices used to farm warmwater fish: biology and biological requirements of main species eg carp, tilapia and catfish; methods used to recognise gender in each species; diets for broodstock; natural and artificial methods of spawning, incubating eggs and rear frying; indicators of first feeding fry; feeding schemes used to rear fry; water and site requirements of farms rearing these species; use of recirculated systems in these industries; nature, preparation and use of ponds to culture these species; carrying capacity for ponds; range of husbandry options available to intensify production; methods used to harvest these species; importance of natural diets for these species; main disease problems associated with warmwater fish production; bio security; animal welfare issues; health and safety; relevant current legislation and codes of practice

3 Understand the principles used to farm marine fish

Principles used to farm marine fish (excluding salmonids): biological requirements of farmed marine fish; farming cycles and production problems; broodstock nutrition and maintenance; methods used to spawn broodstock; methods used to incubate eggs; development of larvae and fry and the methods used to rear them; nutritional requirements of fish; methods of controlling contamination; environmental and sustainability issues; methods used to on-grow farmed marine fish (onshore and offshore); methods used to harvest farmed marine fish; main disease problems associated with marine fish production; bio security; animal welfare issues; health and safety; relevant current legislation and codes of practice

4 Be able to produce live food for warmwater and marine aquaculture

Live food production techniques: requirements of warmwater and marine fish for live foods; methods used to rear and produce live foods eg rotifers, artemia, copepods; methods of nutritional manipulation (enrichment) of live foods; issues associated with live food production methods eg contamination, nutritional deficiency; mesocosm strategy pond preparation and live food harvesting; disinfection requirements; use of pre and probiotics in live food culture; sustainability issues associated with using live foods; potential risks associated with using live foods as a production method for warmwater and marine fish; animal welfare issues; health and safety; relevant current legislation and codes of practiceAssessment and grading criteria

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:**
P1 describe the main global warmwater and marine aquaculture industries		
P2 compare their production to that of capture fisheries and other major aquaculture industries [CT]	**M1** discuss current and potential limitations for the growth of warmwater and marine aquaculture	
P3 explain site requirements for an on-growing farm for a selected warmwater freshwater species to meet given objectives		
P4 evaluate natural and artificial techniques used in the breeding of a selected warmwater freshwater species [IE]	**M2** evaluate various systems for the production of a named warmwater fish species	**D1** evaluate the potential problems of farming non-native warmwater fish species in the UK
P5 explain the methods used to rear a selected species of commercially cultured marine fish		
P6 discuss the biological and nutritional requirements of farmed marine fish	**M3** explain the commercial production of fry for a named species of marine fish	**D2** evaluate the use of offshore production methods in marine fish aquaculture
P7 rear a selected species of live food used in commercial warmwater freshwater aquaculture or in commercial marine fish aquaculture [TW]		
P8 state reasons for the methods used. [RL]	**M4** explain the reasons for live food enrichment for marine fish larvae, including the common problems associated with the process.	**D3** evaluate selected live food types in relation to the production, requirements and nutritional status of fish larvae.

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.

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

Essential guidance for tutors

Delivery

Delivery is likely to be a mixture of classroom learning and practical aquaculture activities. 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 undertake the production of live foods 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 or an aquarium curator responsible for live food production could talk about their work, the situations they face and the methods they use. Whichever delivery methods are used, it is essential that tutors stress the importance of animal welfare, sound environmental management, bio security and the need to manage the resource using legal methods.

Health and safety issues relating to working around water as well as zoonotic risks must be stressed and reinforced regularly, and risk assessments must be undertaken before any practical activities. Laboratory practicals involving live foods should involve evaluation of health and safety issues, for example control of substances hazardous to health (COSHH) assessments associated with the activity. Adequate personal protective equipment (PPE) must be provided and used for laboratory and practical sessions.

Learning outcome 1 covers the development and current scale of warmwater and marine aquaculture industries globally and in the UK. This is likely to be delivered using formal lectures, discussion, site visits and independent learner research. Use of various websites, for example the Food and Agriculture Organisation (FAO) website, can give current information on the industries and provide details on the production of a range of species.

Learning outcome 2 covers the principal farming techniques associated with warmwater fish. This area is likely to be delivered using formal lecture, discussion, site visits and independent learner research. Site visits are likely to play an important part in the delivery of this unit.

Learning outcome 3 covers the principles and practices of farming techniques associated with marine fish. This area is likely to be delivered using formal lecture, discussion, site visits and independent learner research. Site visits are likely to play an important part in the delivery of this unit.

Learning outcome 4 covers the diverse range of live foods available for aquaculture.

This area is likely to be covered through formal lectures, discussion and independent learner research to begin with. Laboratory or hatchery-based supervised practical sessions will then be used to cover the practical elements of live food production and manipulation. Site visits and visiting speakers will develop learners' knowledge further.

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
Introduction to the unit.
Introduction to the aquaculture industry.
Environmental problems and future concerns and risks.
Development, markets, potential markets and competitors.
Assignment 1: The Industry (P1, P2, M1) Introduction assignment.
Aquaculture and the wild fish capture industry.
Biological requirements for the major warmwater fish species and farming methods.
Systems and methods used in warmwater aquaculture.
Husbandry for warmwater species.
Assignment 2: Warmwater Aquaculture (P3, P4, M2, D1) Introduction assignment.
Biological requirements for the major marine fish species and farming methods.
Systems and methods used in marine aquaculture.
Husbandry and fry production for marine species.
Assignment 3: Marine Aquaculture (P5, P6, M3, D2) Introduction assignment.
Requirement for live food.
Methods used to produce live food.
Practical: set up and practise live food production.
Assignment 4: Live Food production (P7, P8, M4, D3) Introduction assignment.
Problems with live food production and food enrichment.
Unit review.

Assessment

For P1 learners must describe the main global warmwater and marine aquaculture industries. They will be expected to describe all the major areas of production for both industries. Evidence could take the form of a presentation, an annotated poster, webpage or leaflet, or possibly a project.

P2 requires learners to compare their production to that of capture fisheries and other major aquaculture industries. Learners will probably combine this with evidence from P1, using all the major areas identified in P1 to compare with other forms of food fish production. Evidence is likely to take the same form as for P1.

For P3 learners are required to explain the site requirements for an on-growing farm for a selected warmwater species to meet given objectives. The selected species should be identified in discussion between the tutor and learners. Evidence could be in the same form as for P1.

For P4 learners must evaluate natural and artificial techniques used in the breeding of a selected warmwater species. The selected species should be identified in discussion between the tutor and learners. Evidence should include an explanation of the management of the broodstock (selection and indicators of maturity), spawning, fertilisation and incubation of the eggs. Learners must also include details of the main physiological changes occurring in the fish. Evidence could be in the form of a report or a presentation.

For P5 learners must explain the methods used to rear a selected species of commercially cultured marine fish. The selected species should be identified in discussion between the tutor and learners. It is expected that the choice of species should be limited to farmed species, rather than ranched or fattened species. Learners should ensure that they describe the full production cycle, from hatchery to harvest. Evidence could be in the same form as for P1.

P6 requires learners to discuss the biological and nutritional requirements of farmed marine fish. Learners will be expected to identify the main requirements and should relate these to a single identified species as an example of industrial practice. Evidence could be in the form of an information note, annotated poster, web page or project.

For P7 and P8 learners are required to rear a selected species of live food used in commercial warmwater or marine fish aquaculture and state the reasons for the methods used. The selected species should be identified in discussion between the tutor and learners. This selection process should be carried out with due regard to the complexity of the production method, the hatching of dried artemia would not be sufficient. It is likely that this will be assessed directly by the tutor during practical activities and therefore evidence will be in the form of observation records completed by learners and the tutor and accompanied by appropriate worklogs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

For M1 learners are required to discuss current and potential limitations to the growth of warmwater and marine aquaculture in the UK. The limitations considered should be wide ranging and include industrial, ecological and economic factors. Evidence could be in the form of an information note, annotated poster, webpage or project.

M2 requires learners to evaluate various systems used for the production of a named warmwater fish species. Tutors should identify the species or agree them through discussion with learners, but it must be a significant species in the industry. All different systems must be identified and evaluated. Evidence could be in the same form as for M1.

For M3 learners are required to explain the commercial production of fry for a named species of marine fish. The selected species should be identified in discussion between the tutor and learners. The explanation must include the management of the broodstock, broodstock selection, indicators of maturity, artificial spawning, fertilisation and incubation of the eggs, first feed and weaning. Learners must describe commercially viable methods. It is possible for this to be completed alongside P5.

M4 requires learners to explain the reasons for live food enrichment for marine fish larvae, including the common problems associated with the process. The reasons and problems considered should be wide ranging and include industrial, ecological and economic factors. Evidence could be in the same form as for M1.

For D1 learners are required to evaluate the potential problems of farming non- native, warmwater fish species in the UK. Learners should consider the ecological, technical and financial problems associated with such an enterprise. Learners could contextualise their evidence for a specific species. Evidence could be in the same form as for P1.

D2 requires learners to evaluate the use of offshore production methods in marine fish aquaculture. Evidence should consider the reasons for developing offshore production as well as the technical requirements for and problems in production. Learners could contextualise their evidence for a specific species. Evidence could be in the same form as for P1.

D3 requires learners to evaluate selected live food types in relation to the production, requirements and nutritional status of fish larvae. Learners should compare a live food type which requires nutritional manipulation with one that does not. This may be for one or more fish species. Evidence should also consider the relevant production requirements for each live food. Evidence could be in the same form as for P1.

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	The industry	You are required to investigate the aquaculture industry for a magazine article on the future of the industry. Describe the main marine and warmwater aquaculture industries. How do these compare with the current wild capture fisheries? How is the industry going to cope with the current and future limitations, particularly climate change and wild fish limitations?	Written report.
P3, P4, M2 D1	Warmwater aquaculture	You need to evaluate the possible success of an aquaculture business. Explain how the selected business meets the requirements of an on-growing site. Describe the various natural and artificial techniques used for breeding and the various systems for the production of fish species and evaluate them against suitability for use in the selected site. What are the potential problems for the selected site? Evaluate them against the possible success of the venture.	Written report.
P5, P6, M3 D2	Marine aquaculture	You need to evaluate the possible success of a marine fish production business. Explain the methods used to rear marine species and evaluate the chosen site for suitability. Discuss the biological and nutritional requirements of marine species and evaluate selected species in terms of suitability for the chosen location. Explain how you would commercially produce fry for the production business. Evaluate how offshore farming could help your chosen production business.	Written report.
P7, P8, M4 D3	Live food production	You are required to produce a live food diet for a specified fish farm. Complete this task and state the reasons for the production method used. Show why live food is so vital for marine larvae and how food enrichment helps to produce larvae and fry. Evaluate the various live food types in relation to production requirements and nutritional status of fish larvae.	Work log, witness statements, written report.

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 Fish Farming	Understand the Principles and Carry Out Practice of Exotic Animal Health
	Understanding Aquaculture Systems
	AQU6 Prepare to and feed fish

Essential resources

Learners will need supervised access to a facility where they can produce and maintain live foods. Commercially relevant equipment must be used.

Learners must also have access to current information relating to the farming of warmwater and marine fish species.

Tutors delivering this unit should be competent and experienced fish farmers.

Employer engagement and vocational contexts

This unit focuses on understanding the warmwater and marine aquaculture industries and the fundamental methods and systems required. There is some emphasis on the practical skills needed to work within the industries. Learners should be encouraged to develop this knowledge during work experience placements. Guest lectures and site visits should also be used to highlight how this knowledge is essential within the industries. It should also be recognised that the good husbandry skills required for the practical element of this unit are essential, transferable skills.

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

Edwards P, Little D and Demaine H – *Rural Aquaculture* (CABI Publishing, 2002)ISBN 0851995659

Egna H and Boyd C – *Dynamics of Pond Aquaculture* (Lewis Publishers US, 1997) ISBN 1566702747

Horvath L, Tamas G and Seagrave C – *Carp and Pond Fish Culture, 2nd Edition* (Blackwell Science, 2002) ISBN 0852382820

Jhingran V and Pullin R – *A Hatchery Manual for the Common, Chinese and Indian Major Carp* (International Specialized Book Service, 1988) ISBN 9711022176

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

Moksness E, Kjorsvik E and Olsen Y – *Culture of Coldwater Marine Fish* (Blackwell Science, 2004) ISBN 0852382766

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

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

Stickney R and McVey – *Responsible Marine Aquaculture* (CABI Publishing, 2002) ISBN 0851996043

Stottrup J and McEvoy L – *Live Feeds in Marine Aquaculture* (Blackwell Publishers, 2003) ISBN 0632054956

Journals

Aquaculture

Aquaculture Europe

Aquaculture International

Fish Farming International

Journal of World Aquaculture Society

Progressive Fish Culturist

Websites

www.ag.arizona.edu/azaqua	Arizona Aquaculture
www.aquaculture.stir.ac.uk	Institute of Aquaculture
www.aquanet.com	Aquatic Network
www.aquanic.org	Aquatic Network Information Centre
www.defra.gov.uk	Department for Environment, Food and Rural Affairs
www.easonline.org	European Aquaculture Society
www.enaca.org	Marine Finfish Aquaculture Network
www.fao.org/fishery/en	Food and Agriculture Organisation
www.feap.info/feap	The Federation of European Aquaculture Producers
www.fish.wa.gov.au/aqua	Pearling and Aquaculture
www.reed-mariculture.com	Reed Mariculture site information on instant algae
www.was.org	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 ...
Independent enquirers	evaluating natural and artificial techniques used in the breeding of a selected warmwater species
Creative thinkers	comparing their production to that of capture fisheries and other major aquaculture industries
Reflective learners	stating reasons for the methods used in the production of live foods
Team workers	rearing a selected species of live food.

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 ...
Independent enquirers	describing the main global warmwater and marine aquaculture industries
Creative thinkers	discussing current and potential limitations for the growth of warmwater and marine aquaculture industries
Reflective learners	evaluating natural and artificial techniques used in the breeding of a selected warmwater species
Self-managers	rearing a selected species of live food
Effective participators	discussing current and potential limitations for the growth of warmwater and marine aquaculture industries.

Functional Skills – Level 2

Skill	When learners are;
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing current and potential limitations for the growth of warmwater and marine aquaculture industries discussing the biological and nutritional requirements of farmed marine fish
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	comparing the production of global aquaculture to that of capture fisheries evaluating various systems for the production of a named warmwater fish species
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	discussing current and potential limitations for the growth of warmwater and marine aquaculture industries evaluating natural and artificial techniques used in the breeding of a selected warmwater species