THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

# Aquaculture production – Lecture 2

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# Learning outcomes

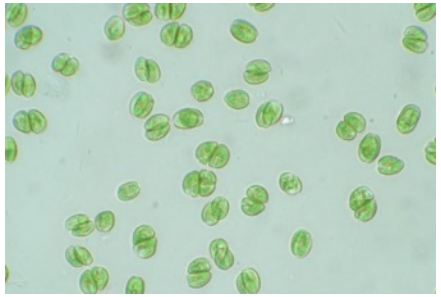
- Importance of aquaculture
- Recognise common aquatic species cultured globally and in Australia
- Describe observed trends in aquaculture production globally
- Describe differences between culture methods and systems
- Recognise important factors for nutrition, water quality and disease management
- Familiarity with government regulations affecting Australian aquaculture
- Role of veterinarians in aquaculture

# Nutrition

- Correct nutrition required for optimal growth, health and reproduction
- Complete nutrient requirements only available for select species
- Utilisation of proteins, lipids and/or carbohydrates can vary (carp *vs.* salmon)
- Feed costs can represent 40–50% of overall cost (intensive production system)

# Live feeds

- Examples:
  - Microalgae
    - Mostly unicellular
    - *Isochrysis*, *Chaetoceros, Tetraselmis*
  - Rotifers (early protostomes)
  - *Artemia* (crustacea)
- First feed for many larvae
- Balanced diet and highly palatable
- Can be produced in bulk
- Expensive to purchase (*Artemia*) or maintain in culture (algae)



# Trash fish feeds

- e.g., sardines, pilchards and squid
- Fresh or freeze-thawed
- Balanced diet and highly palatable
- Supplemented with vitamins and minerals
- Often used to condition broodstock
- Can represent a substantial cost to production
- Global pressure on wild stocks

(fish oil and meal)

- Risk of introducing disease

Southern Bluefin Tuna

# Artificial (prepared) feeds

- Uniform quality and variable size
- Nutrients balanced for maximum growth
- Easy to store and distribute
- Generally lower cost
- Can be a moist or dry pellet
- Often contain fish oil and fish meal (nutritional balance and improved palatability)
- e.g., 50 % of the world fish oil production is fed to farmed salmon



carotenoids

# Water quality control

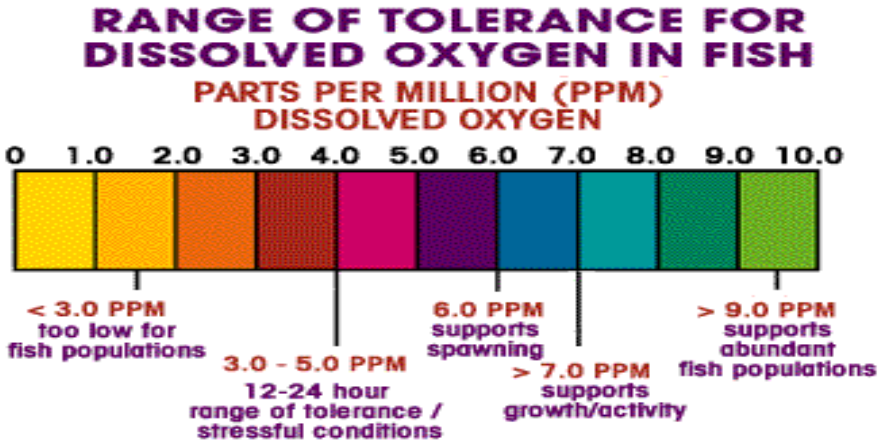
- The primary consideration when culturing aquatic organisms
- Physical and chemical properties of water must be carefully monitored to ensure growth and survival
- Tolerance varies by species

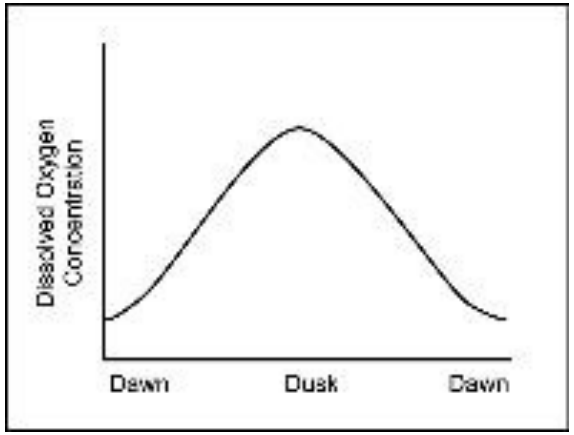
- **Most important parameters: dissolved oxygen, temperature and total nitrogen**
- Others:  pH, salinity, alkalinity, hardness, turbidity and pollution (pesticides and herbicides)

# Dissolved oxygen

- Tolerance varies but > 5 ppm
- Low dissolved oxygen can cause

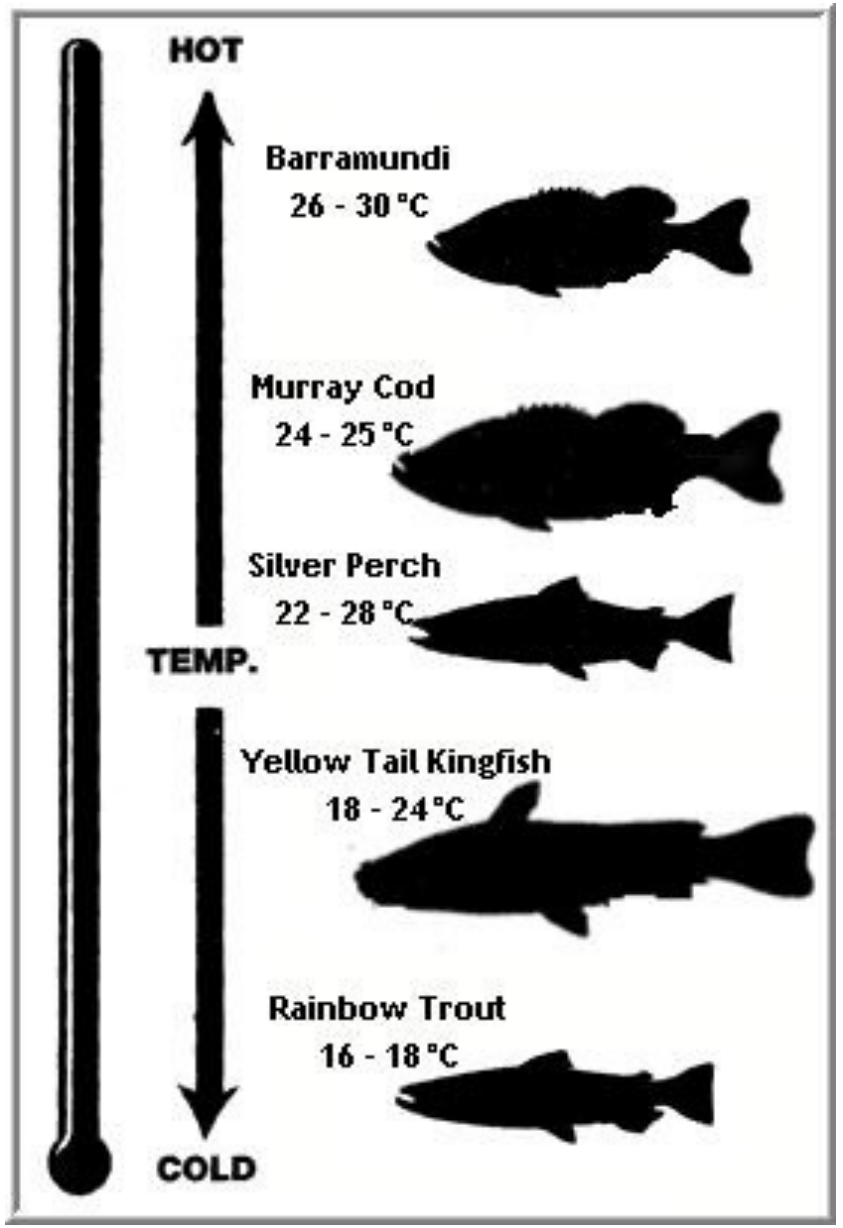
  hypoxia = stress = death and disease
- Dissolved oxygen decreases at higher temperatures and decreases with increased altitude and salinity
- Phytoplankton consume oxygen at night and produce oxygen during the day
- Can change rapidly in closed system (ponds)
- Intensive aquaculture requires supplemental aeration (equipment and electricity costs)



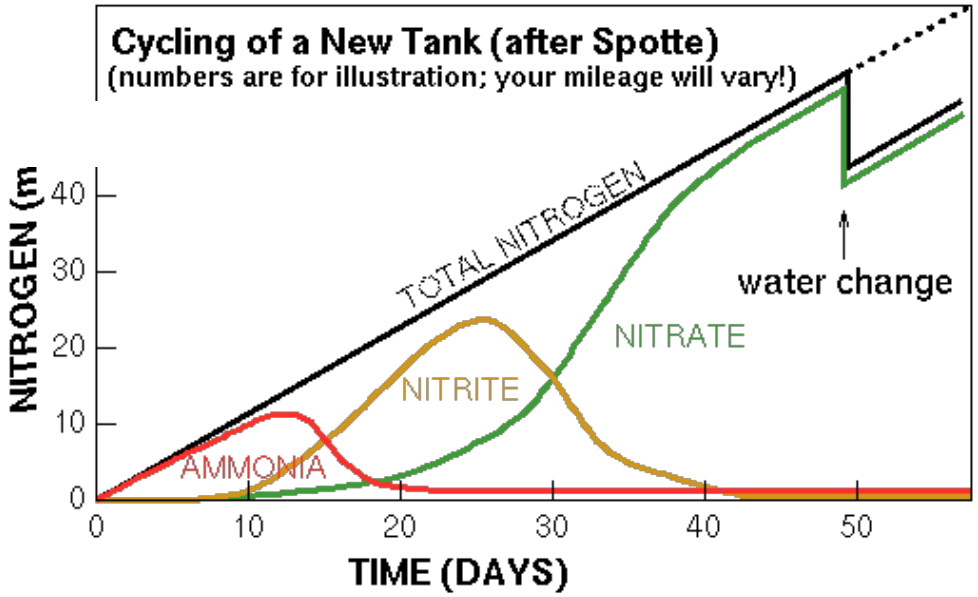

# Temperature

- Cultured species are ectothermic (assume temperature of their environment)
- Affects activity, behaviour, growth and reproduction
- In fish, metabolic rates double for every 10 °C (until optimal)
- High temperature can cause stress = death and disease
- Can cause stratification (affects dissolved oxygen)
- Buffered in open systems and ocean
- Can change rapidly in closed system (ponds)
- Select right environment for your species (e.g., salmon in Tasmania)



# Nitrogen waste products

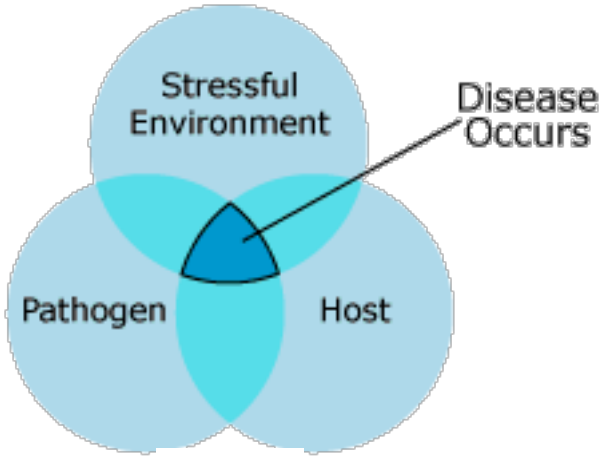
- Aquatic species excrete nitrogenous waste using gills (primarily as ammonia)
- Ammonia (toxic) converted rapidly to nitrites ($NO_2$) then nitrates ($NO_3$) by bacteria
- Ammonia can cause gill and tissue damage, extreme lethargy and death




- Can change rapidly if fish metabolising high protein diets
- Nitrogen taken up by aquatic plants – promotes algal blooms (and more toxins!!)
- Dispersed quickly in open systems
- Can change rapidly in closed system (ponds)

# Diseases in the aquatic environment

- Fish and shellfish held under high stocking densities are naturally susceptible to infections
- Stress is the major contributing factor
- Secondary infections are common, and diseases are frequently reported as syndromes of mixed aetiology



# Monitoring disease in the aquatic environment

- Signs of disease:
  - Mass mortality events
  - Behavioural change – decreased feeding, change in swimming pattern
  - Gross pathology – change in colour, tissue necrosis and secondary infections


# Diseases affecting aquaculture

- Environmental factors:
  - Hypoxia
  - Toxins
- Infectious agents:
  - Virus
  - Bacteria
  - Fungi
  - Parasites

# Disease management

- Prevention
  - Quarantine – confine new stocks before release into culture tanks
  - Regular disease monitoring
  - Maintain water quality
  - Maintain a stress-free environment
  - Vaccination – injectable or bathing
- Treatment
  - Antibiotics - oral, injectable or bathing
  - Salt or freshwater baths
  - Others: formalin or other veterinary prescribed chemicals

# Bacteria

- Often virulent and avirulent strains
- Treatment
  - Usually oral, injectable or bathing treatment with antibiotics
- Prevention
  - Vaccination is available for some
  - Probiotics – non-pathogenic bacteria
- Often a secondary infection
- Some primary pathogens and need to be carefully monitored
- Examples

# Bacteria - Australian aquaculture

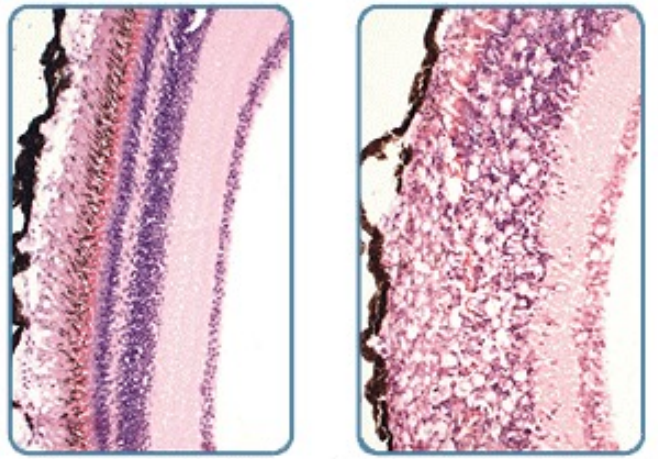
- Atypical *Aeromonas salmonicida* biovar Acheron
  - Virulent strains of *Aeromonas* spp.
  - Salmon industry (Macquarie harbour)
  - Blood disease – septicaemia
  - Raised, fluid filled lesions and necrosis of the internal organs
  - Antibiotics administered orally in feed
  - Injectable vaccines available
- Vibriosis
  - Virulent strains of *Vibrio* spp.
  - Cutaneous and systemic haemorrhages
  - Problem in marine hatcheries
  - Antibiotics administered orally in feed
  - Vaccine available for fish

# Virus – Australian aquaculture

- Australian aquaculture not virus free but many remain exotic
- Prevented through strict quarantine procedures
  - Impacts fish and shellfish imports into Australia
  - Impacts live fish movement between states
- Diagnostic protocols used to monitor most viral pathogens (PCR)
- Virus isolation is also used by most state and federal laboratories
- No treatments or vaccines for viral infections in Australia

- Pacific Oyster Mortality Syndrome (POMS)
  - Ostreid herpesvirus-1 microvariant (OsHV-1 µ-var)
  - Pacific oyster production in NSW and Tasmania
  - Can cause significant mortalities in entire bays
  - Movement of oysters and oyster equipment from high risk areas requires a permit

- Viral encephalopathy and retinopathy
  - Nodavirus infects brain and ocular tissues of barramundi
  - Can cause significant mortalities in larvae and juveniles
  - Broodstock and larvae at hatcheries regularly screened using diagnostic PCR



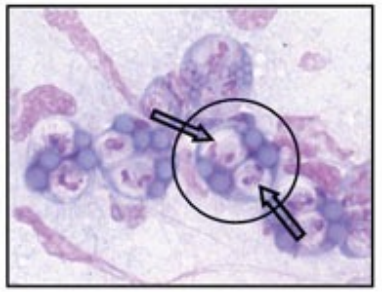

- Gill associated virus
  - Family Roniviridae
  - Prawn production in Queensland
  - Can rapidly become systemic infection which causes mid crop mortality syndrome
  - Present in wild broodstock, therefore difficult to control
  - PCR & monitor water quality - strongly associated with stress events

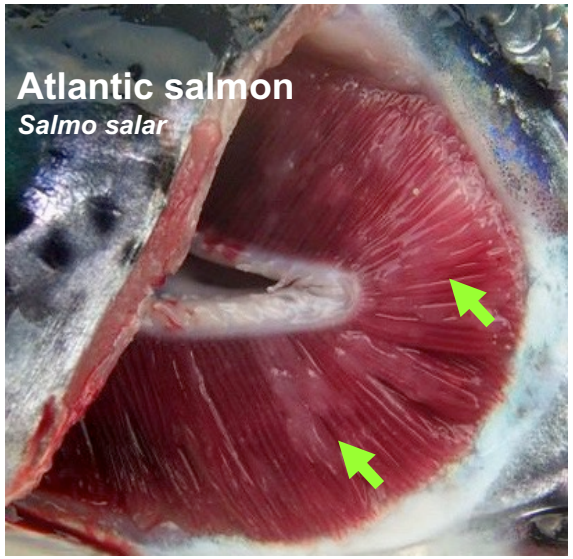
# Fungi

- Not common in marine/brackish water aquaculture
- Observed in freshwater hatcheries (e.g. rainbow trout)
- Epizootic ulcerative syndrome (EUS)
  - Affect many freshwater species
  - *Aphanomyces invadans* infection following initial damage
  - Monitor water quality

# Parasites

- QX disease
  - Sydney rock oysters in NSW
  - Paramyxean protozoa *Marteilia sydneyi*
  - Prevent movement of oysters and oyster equipment
- Amoebic gill disease
  - Atlantic salmon in Tasmania
  - Marine amoebae attach to gills
  - Change to the gill tissue leads to mortalities
  - Treat with freshwater bath



# Markets and future direction

- Australia = safe, high-quality seafood, produced using environmentally sustainable practices
- High-value domestic and overseas markets
- Further processing and identifying packaging to “value-add”
- Increasing demand for high quality Australian native species (barramundi and abalone) in Asian markets


# Australian aquaculture regulations

- Australian Government manages national programs for:
  - Research – FRDC/CSIRO/AIMS
  - Management of biosecurity
  - Aquatic animal health
  - Food safety
  - Environmental management
  - Market access and trade
- Elements of the monitoring and regulation of domestic aquaculture production rest with the states and territories
- Regulation of international sale and movement of aquatic species occurs at all levels (state, federal and international partners).

VET FUTURES

# Vets and aquaculture: an evolving relationship

Aquaculture is one of the largest farming sectors in the UK, particularly in Scotland. Although veterinary involvement remains small, vets have proved their worth in the industry. As part of *Veterinary Record*'s continuing series of articles discussing the state of different sectors of the veterinary profession, Ronnie Soutar describes the growth of aquaculture and the evolving relationship between the industry and profession

https://pubmed.ncbi.nlm.nih.gov/1926733/

- Aquatic species **are generally not specifically** mentioned in Veterinary Surgeons Acts ~ anyone can diagnose and treat fish disease?
- Fish are covered by medicines legislation so **only vets can prescribe medicines for farmed fish**
- **Emerging sector and veterinary surgeons are critical to the growth and sustainability of it**
- Improving the health status of the fish using preventive medicine and biosecurity strategies
  - Protecting the health of a population
  - Reducing the use of antibiotics
  - Maximise health and welfare outputs

# Summary

- Large diversity of aquatic species cultured
- Aquaculture production increasing
- Variety of culture systems used
- Important to manage water quality, nutrition and disease
- Australia produces high value, sustainable seafood
- Australian aquaculture operations must comply with strict regulations
- Lots of potential for veterinarians as the industry matures