



The No.1 Aquaponics magazine
for the backyard enthusiast.

Issue 3
Third Quarter 2008

Bringing Food Production Home

Backyard Aquaponics

Keeping Trout
- *Oncorhynchus mykiss*

Ladybirds - the good, the bad or the ugly?

The road to Aquaponics - A personal account

Welcome...

Welcome to the third edition of the *Backyard Aquaponics Magazine*. Interest in aquaponics continues to increase and since the last edition there have been numerous mentions of aquaponics in the media. Here in Australia the *Garden Gurus* came down to the Backyard Aquaponics shop and filmed a segment all about aquaponics. The segment created an enormous amount of interest with many people visiting their website and downloading the fact sheet on aquaponics. The segment featuring Neville Passmore can be viewed on the *Garden Gurus*

website www.thegardengurus.tv. Neville was so impressed with the concept of aquaponics that he wanted his garden pond converted into an aquaponics system, and his new aquaponic system has created a lot of interest.

We recently employed the services of a professional magazine designer. This has improved the look and layout of the magazine immensely, and is helping to create a far more enjoyable reading experience within the magazine. We look forward to the ongoing improvements that will be

incorporated into the magazine over the next few issues and if you have any suggestions or comments then please feel free to contact us. ●

Joel Malcolm, Editor



Conversion table

Metric length		imperial
1 millimetre [mm]		0.03937 in
1 centimetre [cm]	10 mm	0.3937 in
1 metre [m]	100 cm	1.0936 yd
1 kilometre [km]	1000 m	0.6214 mile

Imperial length		metric
1 inch [in]		2.54 cm
1 foot [ft]	12 in	0.3048 m
1 yard [yd]	3 ft	0.9144 m

Metric volume		imperial
1 cu cm [cm ³]		0.0610 in ³
1 cu decimetre [dm ³]	1,000 cm ³	0.0353 ft ³
1 cu metre [m ³]	1,000 dm ³	1.3080 yd ³
1 litre [l]	1 dm ³	1.76 pt
1 hectolitre [hl]	100 l	21.997 gal

Imperial volume		metric
1 cu inch [in ³]		16.387 cm ³
1 cu foot [ft ³]	1,728 in ³	0.0283 m ³
1 fluid ounce [fl oz]		28.413 ml
1 pint [pt]	20 fl oz	0.5683 l
1 gallon [gal]	8 pt	4.5461 l

USA volume		metric
fluid ounce	1.0408 UK fl oz	29.574 ml
1 pint (16 fl oz)	0.8327 UK pt	0.4731 l
1 gallon	0.8327 UK gal	3.7854 l

Metric Mass		imperial
1 milligram [mg]		0.0154 grain
1 gram [g]	1,000 mg	0.0353 oz
1 kilogram [kg]	1,000 g	2.2046 lb
1 tonne [t]	1,000 kg	0.9842 ton

Imperial Mass		metric
ounce [oz]	437.5 grain	28.35 g
1 pound [lb]	16 oz	0.4536 kg
1 stone	14 lb	6.3503 kg
1 hundredweight [cwt]	112 lb	50.802 kg
1 long ton (UK)	20 cwt	1.016 t

Temperature Celcius		Fahrenheit
0 °C		32 °F
5 °C		41 °F
10 °C		50 °F
15 °C		59 °F
20 °C		68 °F
25 °C		77 °F

Backyard Aquaponics



Issue 3 • Third quarter • 2008

Backyard Aquaponics Magazine is a quarterly publication which aims to promote the ideas of Aquaponics and home food production coupled with healthy and sustainable living.

Contributors

Joel Malcolm, Faye Arcaro, Carl Schmidt, Max Antuar, John Burgess

Magazine Enquiries

magazine@backyardaquaponics.com

Editor: Joel Malcolm

www.backyardaquaponics.com

Who are We?

Backyard Aquaponics Magazine is produced in-house at Backyard Aquaponics.

PO Box 3350

Success, WA 6964

Ph: (08) 9414 9334

www.backyardaquaponics.com

Proofed and edited by:

Adrian Doesburg

Member of the Society of Editors

BRAVO COMMUNICATIONS

Editors - Copywriters - Proofreaders

08 9498 1555 www.bravocomms.com

Design & Lay-out

David Kyslinger - Moonshine Graphics

Advertising

We are currently looking for advertisers who wish to promote products and services related to aquaponics and home food production.

Contact: magazine@backyardaquaponics.com for information.

Contributions: The articles in Backyard Aquaponics Magazine are submitted by members of the aquaponics community. The editor of Backyard Aquaponics Magazine reserves the right to determine what is published and has the right to modify submitted material where necessary.

Content Disclaimer: Backyard Aquaponics Magazine is published under the explicit understanding that content contained in the magazine is based on the knowledge and understanding of the contributors at the time of writing. Any statements, advice or opinions expressed herein are made for the benefit of the reader only. Therefore Backyard Aquaponics Magazine, or its contributors, will not accept responsibility for any damage or loss which has occurred or may occur as a result of a person's action (or inaction) related to said statements or advice. Backyard Aquaponics Magazine accepts no responsibility for the reliability or accuracy of articles or advertising. Backyard Aquaponics Magazine does not necessarily agree with or accept the views expressed or implied by the contributors.

Copyright © 2008 Backyard Aquaponics. All rights reserved, no part of this publication may be reproduced in any manner or form without written permission.

Contents

Friend or Foe

Ironing out the bugs **04**

Our Favourite Tanks

• Featured Aquaponic Systems

Faye's turnkey system **06**

Our favourite stories

The road to Aquaponics

- A personal account by Carl Schmidt **10**

By the Barbeque

Aquaponically Inspired Recipes

Aquaponic Omelette - A complete meal **13**

On the Deckchairs

Questions and Answers **15**

Fish Anatomy **24**



In the Garage

• This issues Road Test

Trial by Media **17**

By the Pool

• Fish Species for Aquaponics

Rainbow Trout - *Oncorhynchus mykiss* **21**



04



10



17



21

Ironing out the **BUGS**

The good, the Bad or the Ugly?

By Faye Arcaro

Many of the 4000 species of ladybug, lady beetle or ladybird are beneficial to our systems, devouring many of our insect pests which seek to destroy our crops. They are classified as a beetle and belong to the class insecta. They have 3 body parts consisting of thorax, abdomen and head. Their antennae are clubbed and they have 6 legs. Ladybirds are orange to red in colour and this indicates that they do not taste very nice and may be poisonous, deterring many predators. Being a winged insect they have the ability to fly away if they feel threatened or they may just retract and close down, tucking in their wings and feet. An adult ladybird can eat 50 aphids per day and

during the larval stage many consume up to 400 aphids in its short life. Food supplies for ladybirds include mites and if aphids are scarce they will also eat small insects and eggs of moths or beetles. Their size can range from one to ten millimetres depending on the species. These bugs may be purchased and used as a biological control for infestations across the world and are often freed in glasshouses as a natural method of integrated pest management (IPM).

There are ladybirds which eat plant matter and these are the leaf eating ladybirds, easily recognisable by their 26-28 spots on a yellow/ orange mustard coloured background. These pests are not welcome in an aquaponic system as they



Eyed Ladybird

skeletonise the leaves causing them to wither and die. The host plants that leaf eating lady birds eat include plants such as deadly nightshade as well as other solanum species like tomatoes, potatoes, and cucurbits (rock melon, cucumber, marrow, pumpkins and zucchini). The control method for this type of pest in a home garden or aquaponic situation is to hand pick and squash both adult and larva. Destroy infested crop as soon as possible after harvesting fruit to minimize spread.



Ladybird face



Ladybirds mating



Laying eggs

Life cycle

Adult ladybirds become sexually mature within several days of hatching and choose a mate, which they visually recognize as their own species type by having the same number of spots. The male will mount the female and fertilise her eggs. She will then lay between 10 and 50 oval shaped eggs which are cream, yellow or orange. She secures them standing upright onto the underside of a leaf where they are protected. Within 3-5 days the eggs hatch and the larvae emerge, appearing spiky they look nasty and therefore are left alone by predators. The name given to the hatchlings are larva for a single insect and larvae when there are many. The skin of the larva does not grow and will moult 4 times before they pupate, each of the four stages is called an instar. The pupal stage will last between 3 and 12 days before the ladybird emerges as an adult.



Deadly nightshade showing signs of skelētisation

Ladybirds overwinter by finding shelter in the cool months beneath leaf litter or under rocks and the protection of bark. Spring adults appear in search of food and suitable egg laying sites.

Ladybirds can live from a few months to over a year depending on climatic conditions. The life cycle can be completed in 3 to 4 weeks in warmer weather and can take up to 6 weeks in the cooler months.

Attracting beneficial insects

Plants with an inflorescence known as an umbel which include angelica, dill, dandelion, wild carrot and yarrow attract beneficial insects such as ladybirds, bees and wasps. Many people also practice leaving some pest species on their property, this allows more permanent populations of ladybird to be present, so that if pest populations ever start to increase there's a permanent population of ladybird that can quickly increase their population to deal with the pest species. ●

Suppliers of Biological Control Products

- www.goodbugs.org.au
- www.greenmethods.com

Photography by Faye Arcaro



Aphids a Ladybirds favourite meal



Shedding



Spots and colour intensify over time



Eggs on a leaf



Ladybird Larva



New Ladybird

Faye's turnkey system



8 Weeks of impressive growth

By Faye Arcaro

When we decided that we wanted to house an aquaponics system a great deal of thought went into the decision making process. For example, we had to consider the best location so that we didn't have to walk a long way to pick our herbs and vegetables at the end of the day. A few ideas that came to mind were that it should be close to the kitchen or back door, as well as accessible to our outdoor entertaining area, bbq and future pizza oven (Eddy's new project).

While sitting at our kitchen table one day the twenty metre gum tree dropped a massive branch (that's why they call them

widow makers.) We had a revelation at that point, the gum tree could go and that would leave us with a maximum area of 5 X 7.5 metres so we went shopping

and found a patio kit measuring 4.5 X 7.5m, just perfect. Things started to fall into place.

We had to keep in mind that we need maximum sunlight in order for the plants

to grow well and I wanted to be able to harvest even when it was pouring with rain, I also wanted to be able to garden all year round so we chose clear laser

light roofing. We didn't want to block out the light and if it got too hot in summer we could always cover it with shade cloth. A hard cover would allow us to collect rainwater in the winter, minimize evaporation and provide protection from

"I walk out the door on my way to work and throw a handful or two of food at the fish in the morning and about the same when I come home at night"

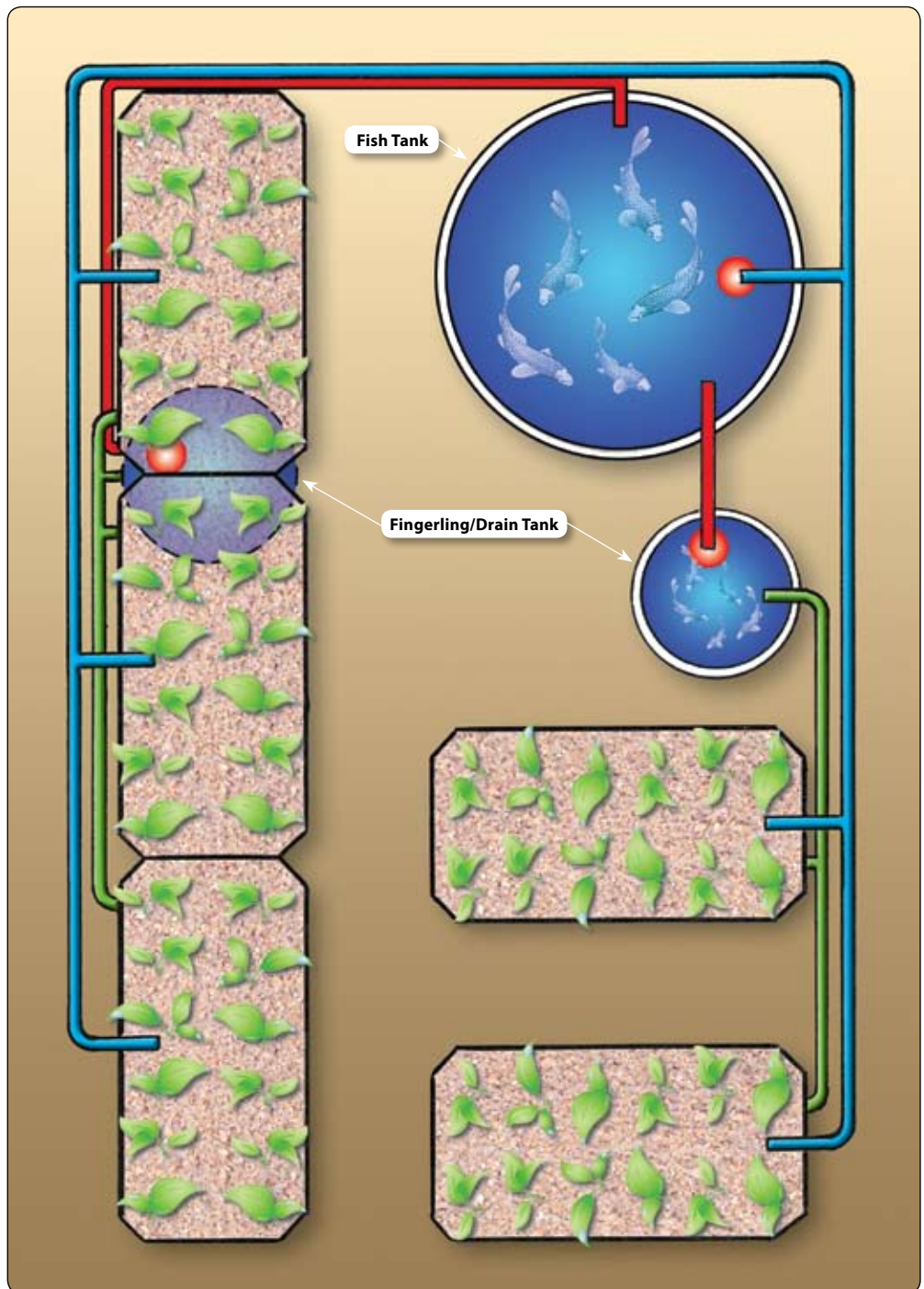
frost and birds as well as keeping the gum leaves out.

The size of the system was determined by the size of our family and as there are five of us we decided that a five bed system would perhaps be an appropriate size. The layout of the system would allow an area for students to gather around the fish tank and amongst the grow beds, while listening to an introduction about the system and how it works. This has been well utilized over the last 18 months as many groups have come and inspected our aquaponic system.

Operation

Our system has its irrigation split in two directions one way to the three grow beds and the other way to the two grow beds. It takes roughly the same amount of time to flood all the beds and when draining each spilt has its own drain tank. The beds are placed around the outer edge of the patio allowing more access and space in the centre.

A timer controls the operation of irrigation to the grow beds which is set on an hourly flood and drain cycle, during which time the beds completely drain. Water is pumped from the main fish tank which at present is home to about one hundred rainbow trout with loads of personality. Every time I walk near they think it is feed time, I try not to disappoint them. The great thing about trout is they have a feed conversion ratio of 1-1 which means that for every kilo of food they eat we get a return of 1kg of fish. The fingerling tank is stocked with a few hides allowing protection for the yabbies.



Overview and layout of Faye's system.

At the beginning of a season we get fingerlings and having an extra drain tank allows me to keep them separate from the main tank while we are still harvesting the larger fish. We have a pump in each drain tank which has a float switch attached to it. When the water level reaches a certain height the

- Irrigation to grow beds
- Growbeds drain to fish tank
- Return line drain tank to fish tank
- Pumps

pump kicks in and returns water to the main tank, this is indicated on the diagram as the return line.

A battery backup pump with air stones ensures that if we have a power outage the fish still have a

supply of air. We put one air stone in the fingerling tank next to the main fish tank and another one in the main tank in case of an emergency.

Production

Perth has a Mediterranean climate with hot dry summers and cold wet winters and our temperatures range from -2 degrees to 45 degrees.

My aim has been to grow seasonal crops, for example vegetables such as cabbage, broccoli and cauliflowers in winter and things like tomatoes, strawberries, rock melons and capsicum in the summer months. Some varieties of lettuce do better than others year round and we pick as early as 4 weeks after planting. I have always found that "you get better results if you try to work with nature rather than against it". For that reason we grow rainbow trout in the cool months as they like cold water up to about 23 degrees. We harvest around October and change to a fish that likes warmer temperatures such as barramundi. I have successfully grown both rainbow trout during winter and



Construction work all coming together

barramundi over the summer.

An aquaponics system allows us to grow a huge variety of food crops and the planting density means we can grow more in a much smaller space than you can in a dirt garden.



Aquaponic trout and salad for dinner.

We enjoy sharing with friends what we have grown ourselves. Family and visitors to our gardens have stated "they have never tasted fresher fish." Our system can easily stock over 100 fish at any time and at the end of the season our freezer is well stocked allowing us to have regular feeds of fish.

Maintenance

At the present moment I walk out the door on my way to work and throw a handful or two of food at the fish in the morning and about the same when I



Abundance of growth



An Aquaponic forest of colour

come home at night. Picking fresh herbs for a pizza topping, a quick quiche or fish and salad keeps us healthy and saves me a lot of time, energy and money.

Usually on weekends I get out with my camera and take pictures of what is happening amongst the plants. Then I'll get the secateurs and trim up things like the tomato plants and old leaves. Last weekend a wattle bird came and had a bath in the fish tank oblivious to the fact that I was hiding behind the

tomatoes. As I was cleaning up one of the beds I noticed something move out of the corner of my eye. At first glance I thought it was an old tomato flower but then discovered that it was a spider which was camouflaged, a great opportunity

to take some photographs.

I have learnt that if you only take a glance you can miss so much. It is when you quiet your mind and potter that you can really see what lives in the underworld of an aquaponic system.

Our mini beasts have such beautifully designed features and the interaction of bugs and insects can be a beautiful thing to watch. Aphids attract ladybirds



Tomatoes ripening-up



A vegetable market on your doorstep

to the garden and it is an absolute joy to watch their life cycle and to be able to share that experience with all the visitors. Watching bees pollinate the flowers and birds calling to collect the caterpillars, just shows you that there is something for everyone in an aquaponic system.

Standing back and enjoying a glass of wine, watching a trout launch itself from the bottom of the tank to catch a mosquito at sunset is just one of the joys of keeping fish? ●

The Road to Aquaponics

A Personal Account

By Carl Schmidt

The following story is a personal account as to how and why I managed to become involved with Aquaponics. For many of you reading this magazine, aquaponics may be regarded as a new area of interest, while for others something that has been experimented with for some time. Whatever the case may be, this amazing method of growing food is strongly gaining popularity worldwide and I think it's pretty clear to see why.

I graduated from Curtin University in early 2002 with a Bachelor of Science in Aquaculture and, like most young university students, couldn't wait to get out into the workforce and begin



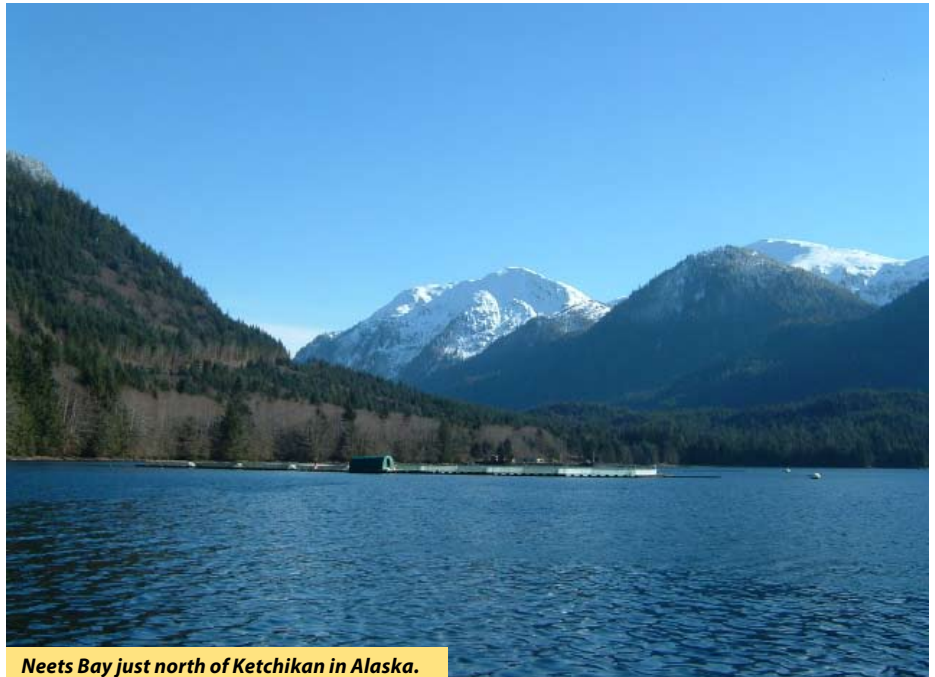
“Growing things in general has been a long time interest of mine, stemming back to my earlier childhood working on my grandfather’s farm near Boddington”

Carl in Tasmania at a bluewater recirculation facility in Wayatinah handling Salmon brood stock.

applying one's knowledge. While in my last year and having belatedly discovered my job prospects in Aquaculture were quite limited within Australia, I applied for several positions in the United States of America before completing my final exams. In case you're wondering I'm fortunate enough to hold dual Australian and American nationality, so applying for jobs in the U.S. was an obvious choice.

It wasn't long and I was on a plane heading north, having accepted a position with the Wyoming Game and Fish Department in a small town called Pinedale. Oh and I do mean small, as there were no traffic lights to be found. Unlike our hills here in Western Australia, western Wyoming has mountain ranges rising to 4,500 metres and is quite a scenic part of the world and one that I would recommend people visit. I spent a year in Pinedale as a field technician working and gaining experience primarily with various fresh water species such as brown, rainbow and brook trout as well as grayling and land locked kokanee salmon. During my contract position, I was also involved with a number of different projects including a major native fish restoration project involving chemical treatments, backpack electro shocking, creel surveys of recreational fishers and a wild spawning and egg collection program.

After completing my contract with the Department, I decided another adventure was in order and so I started to apply



Neets Bay just north of Ketchikan in Alaska.

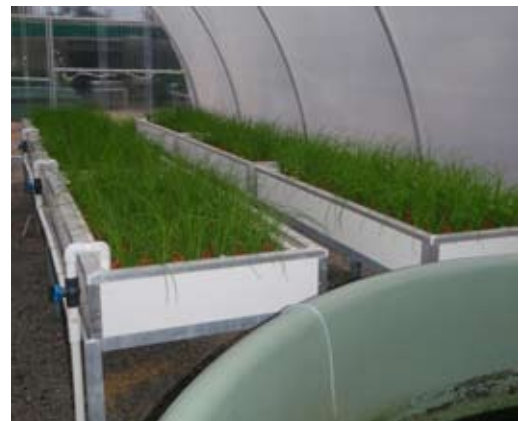
for other jobs within the U.S. Next stop south east Alaska! There I spent a year living and working for the Southern Southeast Regional Aquaculture Association (SSRAA) at their remote salmon hatchery at Neets Bay just north of Ketchikan. By any standards, this is quite a large hatchery, producing in excess of 130 million chum and other salmon species annually for release back into the wild fishery. The experience was certainly an eye opener for me, as it was my first exposure to extensive aquaculture on a grand scale. And like western Wyoming, Neets Bay was far removed from civilisation. The only way to get into town was by float plane which

took about 30 minutes or alternatively via boat, a three hour trip if the weather was favourable. Consequently, I didn't get to town very often. If only I had known more about aquaponics then. All our food was flown in by plane every week and at considerable cost.

After nearly two years away from family and friends, I decided it was time to return to Western Australia, at least for awhile anyway. While back in Perth, I managed a small silver perch hatchery for two seasons in the hills, producing and selling fingerlings primarily to farmers for stocking their dams. However it wasn't long before I had caught the travelling



Carl's 8 bed flood and drain system built behind the Backyard Aquaponics shop.



Carl's first 6 bed system.

bug again, but this time I decided I would try and see a little more of my own backyard and stay a little closer to home. I accepted a hatchery position in Tasmania at a bluewater recirculation facility in Wayatinah working for Salmon Enterprises of Tasmania (SALTAS). The Wayatinah hatchery, which raises Atlantic Salmon, is a highly intensive operation with all the bells and whistles and quite different from the Neets Bay facility. The fish are raised in freshwater on site until they are classed as smolts. Once the smolts are able to handle saltwater they are then transported on trucks to various locations around the state and are grown out in net pens before being harvested. After spending 18 months in the hatchery and having worked with salmon, again it was time to move back to WA and sunnier climes.

You are probably wondering by now how and why I have become involved in Aquaponics and more recently as part of the Backyard Aquaponics team here in Jandakot. Growing things in general has been a long time interest of mine, stemming back to my earlier childhood working on my grandfather's farm near Boddington. I was also exposed to hydroponics during my high school years and subsequently have had several

vegetable gardens. Thus combining both my theoretical knowledge and practical experience in growing fish with my personal interest in growing vegetables, it was perhaps inevitable that I was led to investigate the field of aquaponics. I have not been disappointed with this shift in career focus, as it has certainly proved to be an area worth investigating.

From an aquaculturist's point of view pumping, filtering, aerating and exchanging water in a recirculation system on a daily basis to grow fish can be a relatively expensive undertaking and one that requires careful management and monitoring. Most large aquaculture recirculation systems require a minimum 10% water exchange every day and all of the attendant pumping costs and effluent disposal issues this entails. Thus to be able to grow fish and plants in a small area using a minimal amount of water and to utilize fish waste as a natural fertilizer makes so much sense (or dollars and cents as the case may be).

Earlier this year, I erected a large hothouse behind the Backyard Aquaponics shop and have recently installed my second aquaponics system, an 8 bed flood and drain facility to augment my 6 bed system that I had installed earlier. With the support and guidance of Joel Malcolm and the other Backyard Aquaponics staff, I am currently using this facility to conduct research into the commercial potential of aquaponics and in the process gain a greater understanding as to some of the key issues associated with the installation,

operation and maintenance of larger scale systems.

As everybody is aware, food prices are escalating in Australia and there are now severe food shortages in many countries around the globe due primarily to climate change, increasing fuel and transport costs and the increased use of arable farm land to grow bio-fuels. Locally, sourcing suitable fresh water resources for horticultural and other intensive farming operations is also a major concern in many parts of Australia. Then there is the issue of being able to source high quality fruit and vegetables and our increasing reliance on imported produce. It is in this context that I believe aquaponics has a very bright future ahead, as it offers farmers and backyard enthusiasts with a far more cost effective and environmentally sustainable way of growing high quality food.

Some things are best left to nature! ●



Catching Halibut in Alaska.

Backyard Aquaponics

Bringing Food Production Home

Come and see us online, give us a ring, or pop in and see our shop and display centre for the largest range of aquaponic products available:

- Books, DVD, magazines, manuals
- Complete aquaponic systems
- Pumps, pipe work, fittings
- Tanks and grow beds
- Consulting services
- All aquaponic equipment

+61 (08) 9414 9334
www.backyardaquaponics.com
 Or visit the shop at:
 Cnr Jandakot Rd & Berrigan
 drv, Jandakot, W. Australia



Aquaponic omelette

a complete meal



Interesting facts!

Have you ever wondered what the difference is between a quiche a soufflé and an omelette?

The name quiche is derived from the French word 'kuche' which means cake. Made primarily with eggs and the addition of milk or cream it is baked in an oven and made with a pastry crust. Often savoury flavourings are added such as bacon, vegetables, herbs and cheese.

A soufflé is a light fluffy dish resulting from beating the egg whites before adding to the custard,

it can be served as a savoury main course or sweetened as a dessert. The name comes from the French verb soufflé which means to puff up.

Omelettes are prepared with beaten eggs and cooked in a fry pan using butter or oil and folded around a filling such as cheese and vegetables. They have been described as soft cooked scrambled eggs wrapped in an envelope of firmly cooked scrambled eggs.

Delicious omelette recipe on the next page.

Here's a recipe sent in to us by Max Antuar in Queensland. The recipe sounded so good that we had to try it out.

Method:

Set nonstick fry pan to medium high heat, add Olive oil, then the first 4 ingredients and ground pepper,

- sauté until crisp and tender
- combine egg yolks and next 4 ingredients in bowl , stir well
- beat egg whites in a separate bowl until stiff but not dry, fold into cheese mix, and then
- fold the mix into fry pan, lower heat to medium, and cook until mixture sets, approx 10 to 12 minutes
- Allow to cool slightly, and turn out onto toasted crumpets or multigrain toast.

Enjoy!

Ingredients

- 3/4 cup finely chopped Broccoli florets
- 1 cup sliced Spinach or Silver beet
- 1/4 cup of Red Capsicum
- 1 tsp. minced Garlic
- 4 eggs, separated.
- 1/2 cup grated cheddar cheese
- 3 tbsp.grated Parmesan cheese
- 1/2 cup fresh Basil
- 1/4 tsp Paprika
- ground Pepper and salt to taste
- Olive oil

Recipe By Max Antuar

**Personalized
Aquaponics Help**

Do you feel a little daunted by aquaponics but you'd still love to give it a go?

Faye Arcaro, Gardening Australia's gardener of the year 2007, would be happy to help guide you in setting up and maintaining an aquaponic system.

www.aquaponica.com.au



0422 907 534

(08) 9414 9334



All in the pan.



Joel, Dooley and his wife enjoying the Aquaponic Omelette.

Questions and answers

In Q&A we will cover some of the most commonly asked questions about aquaponics with some simple straightforward answers to help you understand how aquaponics works. If you have any questions you'd like answered please feel free to write to us with your enquiry.

the case with even less aggressive fish species such as Tilapia.

One simple rule to keep in mind is that if you stock a smaller fingerling into a tank with larger fish, be sure that the smaller fish are large enough that they don't easily fit into the mouth of the larger fish.



is decreased as algae in the water consumes the available dissolved oxygen, while at the same time fish will be consuming dissolved oxygen.

You can supplement oxygen requirements at night with other methods of oxygenation like an air pump, however generally it's often easier to continue pumping cycles 24 hours a day.

Question: Can I have more than one species of fish in an aquaponic system?

Answer: Yes, it's quite feasible to have different species of fish in your system, however you will need to keep a few things in mind when stocking with multiple species. Some fish species can be aggressive by nature, if you are growing an aggressive species such as Trout or Barramundi in your system, then you can't stock the same tank with small fingerling. This can also be

Question: Do I have to run my aquaponic system at night?

Not necessarily, it depends on the system and your stocking density. Although plants produce oxygen during the day through the process of photosynthesis, they also consume oxygen at all times through other biological processes that happen day and night. During the day they produce far more oxygen than what they consume. This means that during the night oxygen availability



Question: Can I use goldfish in my aquaponic system?

Yes. Goldfish or other varieties of comets, fantails etc. can easily be used as a nutrient supply in an aquaponics system. These fish are often stocked by people who have no interest in having edible fish species.

We have found through trials of different fish feed that you need to feed the fish a quality feed, otherwise mineral deficiencies can show in plants. Mineral deficiencies can generally be easily remedied though by the addition of minerals into the system, often in the form of seaweed extract.

Questions: Will earthworms live in a growbed?

Yes. Worms are very useful in growbeds for breaking down old root matter and other wastes pumped into

the beds from the fish tank. Worms help mineralize these wastes into "worm tea" which becomes

valuable for uptake by the plants growing in the growbeds.

Many people have expressed surprise that worms would live in an environment that is regularly flooded by water as the common thought is that worms do not like being flooded, and will die. This is not such an issue in the growbeds because the water is generally well oxygenated and worms

can survive in well oxygenated water, it's only when water is stagnant and has low levels of dissolved oxygen that they suffer. ●



Aquaculture Hydroponics Aquaculture Hydroponics

AQUAPONICS

Journal

The Voice of the Aquaponics Industry

- Feature Stories
- Research
- Education
- Commerical
- Hobby
- How-To
- System Design



- Q and A by Dr. James Rakocy
- Happenings
- Aquaponics Around the World
- Industry News
- Editorials

Published continually since 1997

www.aquaponicsjournal.com

Trial by media

By Carl Schmidt

We often have enquiries from aquaponic enthusiasts regarding what type of grow bed media should be used in an aquaponic system. There are a number of materials which may be used in aquaponic systems including perlite, vermiculite and coco peat, along with harder rock and clay media. The type of media you use in a system may depend on your system design. These lightweight media are acceptable for supporting plant roots and sustaining plant growth but are not particularly well suited to flood and drain recirculation aquaponic systems, where they can be inclined to float easily and are likely to break down over time and clog pipes. We set up a trial of different media types to see if there are any significant differences in performance. Described below are the four types of media we tested in the systems.

Expanded Clay

Expanded clay is an inorganic material commonly known as LECA (Light Expanded Clay Aggregate) and is also called Hydroton (brand name), fired



clay pebbles or grow rocks. The pebbles are lightweight, chemically inert, durable, pH neutral, sterile, heat proof, reusable and provide good insulation and surface area for bacteria to colonise. They have been used for many years in the hydroponics industry (the purpose for which they were designed) and more recently aquaponics.

The pebbles have a dry weight density of between 300 to 500 kg/m³ and are generally supplied in 45 or 50 litre bags depending on brand. LECA is produced in many countries around the world, made from local clay, an ecologically sustainable medium, which is kiln fired to a temperature of 1200 degrees Celsius where they puff up like popcorn making them lightweight and creating a porous product which helps provide good oxygen levels around the root system.

Expanded clay is available in different sizes such as 4-8mm, 8-16mm, 10-20mm.

Pea Gravel

Gravel is the term given to any loose rock larger than 2mm in size but not larger than 63mm. Pea gravel is simply gravel which has been screened to a certain size. It is most commonly used as a decorative landscaping material in garden design, where it assists with surface drainage or acts as a surface mulch to reduce weed establishment. It is relatively cheap and readily available. However it is also significantly heavy which can present a few problems if used in a conventional aquaponic system, as the growbeds which holds the media must be engineered to hold the weight, and the supports themselves must also be stable enough to support the total weight of the bed when full of water.

This media may contain fine clay particles and requires extensive washing when



compared to some other media. Pea gravel is often available in bulk amounts such as by the cubic metre or trailer load and its weight per volume will depend on the particle size you are purchasing, though as a rule of thumb it's generally about 2.3 ton per cubic metre.

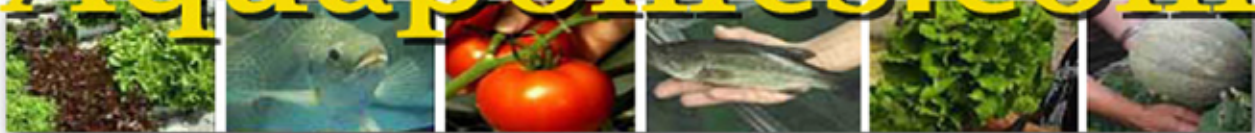
Disease potential is a risk unless the gravel has been supplied by an accredited supplier as it could contain *Phytophthora cinnamomi* commonly known as dieback which poses a threat to many horticultural crops.

Blue Metal

Blue metal as it is known in Australia is a basalt derived aggregate which, like pea gravel, is also commonly used in landscaping as a drainage medium. It is also cheap and available from most landscape garden suppliers



Aquaponics.com



The Source for information on aquaponics, hydroponics and controlled environment agriculture

**Information, Consulting, Books,
Videos, Curriculumms and
Complete Aquaponic System Packages**

**Secure online ordering
Download books and info
We can ship anywhere!**

www.aquaponics.com

**Rebecca L. Nelson, John S. Pade
Aquaponics Consultants
Nelson and Pade, Inc.
Po Box 761, Montello, WI
53949 USA
608-297-8708**

in bulk amounts such as by the trailer or truck load as it is often used in road construction. Unlike expanded clay and pea gravel, blue metal has a rough appearance and sometimes sharp edges which makes it difficult to plant into causing cuts and abrasions on hands as well as broken fingernails making it a less attractive material to work with. Blue metal is extremely heavy weighing in at 2.8 tonne per M3.

This aggregate is made up of 69% feldspars or rock forming minerals including magnesium, iron and silicates as well as a range of other minerals including calcite. One interesting fact is that rock dust often used to improve dirt gardens is predominantly made from crushed rock and contains many beneficial minerals supporting plant health. Magnesium forms a key role in manufacturing chlorophylls which perform photosynthesis, Iron promotes and regulates plant growth and Silicates help strengthen cell walls providing resistance to pest and fungal attack.

Diatomite



Diatomite is a sedimentary rock consisting mainly of decomposed and fossilised single celled organisms derived from algae. It is lightweight when dry although highly absorbent and quite heavy when wet due to its ability to hold water. The media itself is powdery to touch causing skin to dry out if handled without the use of gloves. It is inclined to breakdown over a period of time. Diatomite can be used as an insecticide as the fine powder which extracts lipids from the surface of the insect causes drying out of the exoskeleton, causing irritation until the insect scratches itself to death which makes it useful in the fight against slaters, cockroaches and other bugs. Disadvantages of the use of this product are the risks to human health as well as its non selective nature in killing beneficial bugs such as ladybirds.

Diatomite has a low pH at around 5.5 and a chemical composition including silica, sodium magnesium and iron.

There are a few small deposits in Victoria and also Western Australia, however they are of a low grade quality. In the USA there are guidelines for the maximum amounts allowable in the product and in the air protecting workers from inhaling the dust containing crystalline silica. The potential hazard is determined by the form of silica. Diatomite that has been labelled food-grade contains very low percentages of the silica.



Mould and algae growth on the diatomite

THE TRIAL.....

When determining what media to use in your aquaponic system, there are several different factors that need to be considered. These include:

- **Cost** – particularly important for those trying to stick to a budget. Gravel and blue metal are by far the cheapest media as mentioned above and are readily available from most garden suppliers. Expanded clay and Diatomite are more costly and are only available from selected suppliers.
- **Weight** – gravel and blue metal are both extremely heavy, unlike the expanded clay and diatomite which are both very light. If using a heavy weight media, growbeds and stands need to be well constructed in order to safely support such weight. A solid fixed structure is best.

- **Ease of handling** – this is something that is often over looked when deciding which media to use. Using a light weight growing media makes it easier to handle when constructing a system, but more importantly when planting and harvesting your plants. Expanded clay is undoubtedly easier on the hands, unlike gravel or blue metal which is much harder to work with.

There are however other important considerations including the growth and health of the plants. Consequently each of the 4 grow beds were filled with one of the growing media described above and then planted each with the same plants (lettuces, beetroot, cauliflower, silverbeet, spinach, red and green cabbages) in order to establish any major visual differences in growth between the beds.

The experiment was done during the winter months using Rainbow trout and winter vegetables over a six month period and was outside under shade cloth. Perth experiences cool mild winters with daytime temperatures ranging from 14-25 degrees during the day.

THE FINDINGS.

Overall, there appears to be very little difference between these four different grow bed media, bearing in mind if one was to test these materials more scientifically they would need to compare the same growing media in the one system as well as multiple separate systems. Replication is the key in any experiment. Due to this trial having been operating for only a brief time, we can only report on our preliminary findings based on what we have observed to date. In other words, some grow bed materials may out perform others over a longer time period, but we are yet to determine if this is the case.

After comparing the growth of the plants in all four grow beds after only 9 weeks, we observed very little difference between the four grow bed media. The plants in all 4 beds grew vigorously and we could not discern any significant visual differences in general plant health, although the height of the plants grown in the expanded clay was marginally greater than in the other 3 beds. This could be due to the compaction factor of the material. The expanded clay, because of its round



Growth after 6 weeks

size, has a larger void space between the individual pebbles when compared to the other three media, providing greater aeration for the plant roots in the grow bed. Another interesting observation was with the lettuces grown in the blue metal. The lettuces in the three other beds had some aphids present, while the lettuces grown in the blue metal had virtually none. This could be purely coincidental, however the lettuces have been observed over the entire trial period and nothing has changed as yet.

The system was fed waste produced from rainbow trout fingerlings initially, which have now grown to plate size in the six months. No other additives were needed to grow the vegetables during this time. When the winter vegetables were harvested we began to notice a degree of flooding in three of the beds, these included the media diatomite, blue metal and gravel. This was possibly caused due to compaction of the media as well as the roots clogging the pore spaces before breaking down or being eaten by worms. Also because of the extreme moisture absorbent nature of diatomite the surface of the bed always remains damp, this has led to algae growth over the surface of the media and rotting of some plants which has not been seen in beds using other media.

In conclusion, the preliminary results from this simple trial have shown that any of these four mediums can be used to grow plants successfully, remembering that each one has its own positive and negative attributes when used in an aquaponic system. Though diatomite's disadvantages probably outweigh its advantages in the growing trials we did here. ●

Backyard Aquaponics

Bringing Food Production Home




At Backyard Aquaponics we specialize in system design, supply and installations. We use 3D software to design the best possible system to fulfil a clients needs, and make the best use of available space.

Backyard Aquaponics systems are turnkey packages, this means you get ever thing you need, just add your choice of fish plants and water for a complete running aquaponic system.

Contact us now about a system for your own backyard.

Web: www.backyardaquaponics.com **Phone:** +61 (08) 9414 9334

Mail: PO Box 3350, Success, Western Australia, 6964







Rainbow Trout

Oncorhynchus mykiss

By Joel Malcolm

Rainbow trout are a cool water species of salmonid which are widely distributed around the world. They have been cultured and stocked into dams and rivers in every continent except Antarctica, and are possibly the best known fresh water sporting fish in the world. Rainbow trout prefer cooler water temperatures, with optimum growing temperatures around 13°C (56F) – 17°C (62F). They can tolerate temperatures as low as 3°C (38F) and as high 24°C (75F) but not for extended periods of time.

Rainbow trout kept in optimal conditions can have extremely good Feed Conversion Ratios (FCR) ranging from

1.5:1 down to 1:1. This means that on average you can expect that for every 1.25 kg of feed you can expect to grow 1kg of trout. FCR's are dependent on a number of factors such as water quality,

genetic factors, temperature and feed quality. *Low protein feeds and poorly digestible diets can lead to an FCR as low as 2:1 or worse (Bromage et al., 1990, Gibson's, 1998).*

As rainbow trout have been selectively bred for so many years, generally the genetic makeup of modern rainbow trout means that fish have a very rapid and uniform growth rate, reducing the

need for continual grading of fish sizes. Rainbow trout have a high Dissolved Oxygen (DO) requirement in comparison to many other fish species normally cultivated in aquaponic

Rainbow trout are an ideal choice for aquaponic systems due to their wide tolerance of pure freshwater

systems. However trials of rainbow trout in aquaponic systems around the world have found them to be a very successful species for culture in a range of different systems.

In locations where there are wide temperature fluctuations between summer and winter, trout can be an ideal winter crop with their quick grow-out time. In areas with cooler climates trout make an ideal all year round species. Through trials in our location in Perth Western Australia which has a Mediterranean climate, we have found that having a larger water volume in our fish tanks means less temperature fluctuations as the weather starts to warm up. Smoothing out the daily temperature fluctuations in a system makes for healthier less stressed fish, and as such less chance of diseases becoming a problem. We have also found that shading a system with shade cloth in harsh weather conditions can also aid in controlling temperature fluctuations and extending the grow out period.

Trout may become stressed due to a number of factors such as human intervention and decline in water



Rainbow trout have extremely good Feed Conversion Ratios ranging from 1:5:1 to 1:1

quality. Increased stress levels can lead to physiological changes within the fish. *The main clinical feature of the acute stress response is hyperactivity. Physiologically, there are many alterations. Chief among them are the rapid depletion of intra renal ascorbic acid, an increase in circulating cortisol, cessation of renal and intestinal activity, hemoconcentration, leukocytosis,*

and an increase in blood ammonia. This response is the Alarm Reaction. With the removal of the stressor from the system, the physiological activities return to their original state (George W Klontz, M.S., D.V.M., 1991).

Other effects of increased stress levels include increased susceptibility to latent viral and bacterial infections. Just as humans become more susceptible to diseases and viruses when under increased stress levels, fish also suffer a similar fate. If disease problems do occur in your trout then salt bath treatments will generally be successful as a treatment. Details about treating common fish diseases with salt can be found in the first edition of the **Backyard Aquaponics Magazine** which is readily available for free download from our website www.backyardaquaponics.com

There are many viral and bacterial infections that could be problematic in trout production, however so long as water quality is kept at a high level and fish stress is kept to a minimum, trout are an ideal cool water species for intensive cultivation in aquaponic systems, and should have extremely low mortality



Rainbow trout prefer cooler water temperatures

rates. We have produced numerous crops of trout in different sized recirculating aquaponic systems with mortality rates generally around 0% – 2%.

Rainbow trout are an ideal choice for aquaponic systems due to their wide tolerance of pure freshwater as well as their ability to wow the visitors at feed time where they launch themselves from the bottom of the tank and clear the water in search of a flying insect or pellets. They feed on high protein floating pellets designed for their optimum health and growth. Recent harvests have shown that under optimum conditions have been grown to more than 700grams during the 6 month growing season. ●



Rainbow trout have a high Dissolved Oxygen requirement compared to other cultivated fish species

The Fish Farm

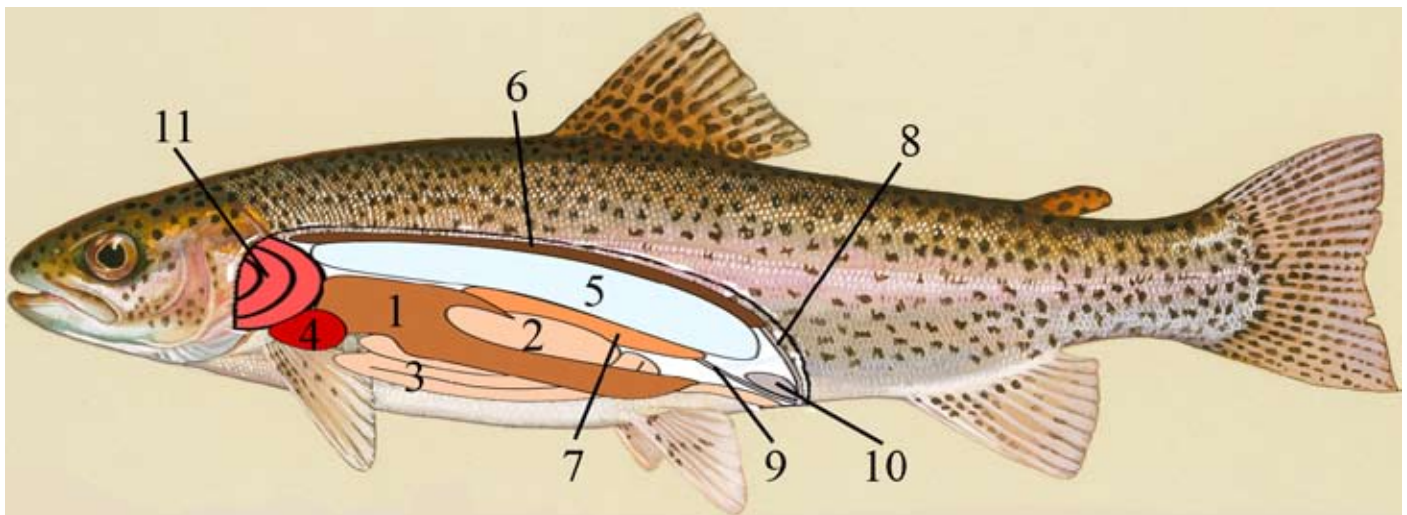
Suppliers of:

- ~Aquarium Supplies and Products*
- ~Aquaponics Products and Systems*
- ~Live Fish and Plants*

www.thefishfarm.com.au

Fish Anatomy

By John Burgess



- | | | | |
|--------------|-----------------|------------------|---------------------|
| 1. Liver | 4. Heart | 7. Testicle | 10. Urinary Bladder |
| 2. Stomach | 5. Swim Bladder | 8. Ureter | 11. Gills |
| 3. Intestine | 6. Kidney | 9. Efferent Duct | |

Every hobbyist should try to acquaint themselves with the external and internal anatomy of the fish they keep. The names of various fins and parts of the body are constantly occurring in the description of the species. I will try to help with the identification and definition of the various fish parts in the following section.

Body Shape

Generally fish are "torpedo shaped" with rounded nose, a thicker middle and a tapered tail.

The external structure offers little resistance to the water. The body is spindle shaped, somewhat heavier toward the front than the rear and the

cross-section is elliptical.

The head is integral with the body. Also the body is generally free of projections that might offer resistance. The eyes are smooth and do not extend beyond the contours of the head; the gill opening is covered by a smooth flap (operculum); and the scales lie closely against the body surface.

Of course the fins protrude but these stabilise the fish. They can be folded along the body during rapid swimming and act as brakes when erected.

The head of the fish has its mouth, nostrils and gill cover. The gills (found under the gill covers) allow the fish to breathe. As water moves over the surface

of the gills, oxygen is absorbed - like lungs in land creatures.

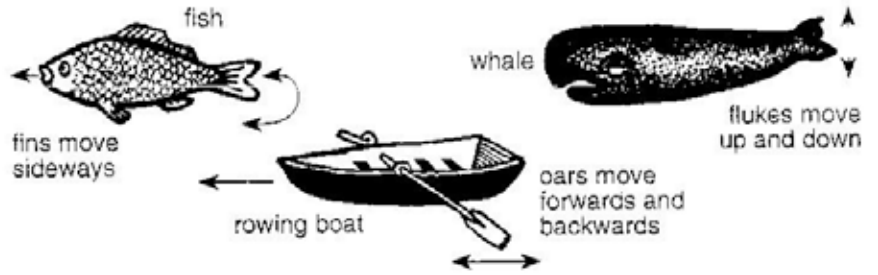
Nervous System

In comparison with higher vertebrates a fish's nervous system is poorly developed. The brain is extremely small in relation to body size. The lack of 'grey matter' is particularly appalling in the bony fish (such as herring and perch) because in this group the cerebrum, traditional centre of thought and reason, is almost totally lacking.

Also fish have relatively few, poorly developed nerves. Therefore their ability to experience sensations such as pain would be diminished in comparison to higher vertebrates.

Fins

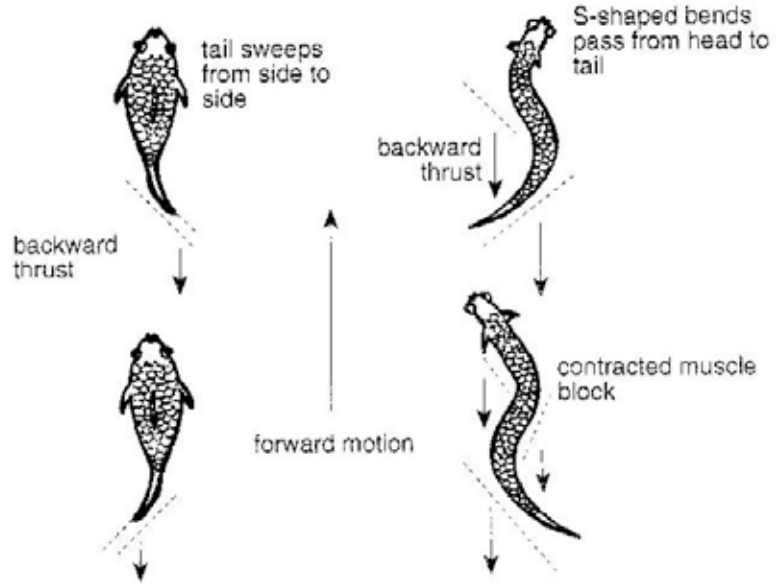
Fins help the fish swim. The large muscles of the body actually do most of the work, but the fins help with balance and turning. The fins are made up of stiff rays covered by skin. Some may be jointed and some separate near the edge of the fin.



In certain fish, some of the rays supporting the fins are bony, stiff, unjointed, and spiny. They help protect the fish from its predators who do not want a mouthful of sharp spears!

Fins are of two general types, paired or unpaired (and median). The paired pectoral and pelvic (ventral) fins correspond to the fore and hind limbs of terrestrial vertebrates.

The unpaired fins are the dorsal (back), caudal (tail) and anal (belly) fins. Fish never have more than two pairs of paired fins (some only have one pair) but the number of dorsal and anal fins varies widely.



Fin Functions

Each fin on a fish is designed to perform a specific function. I will list them here.

Dorsal fin – Lends stability in swimming.

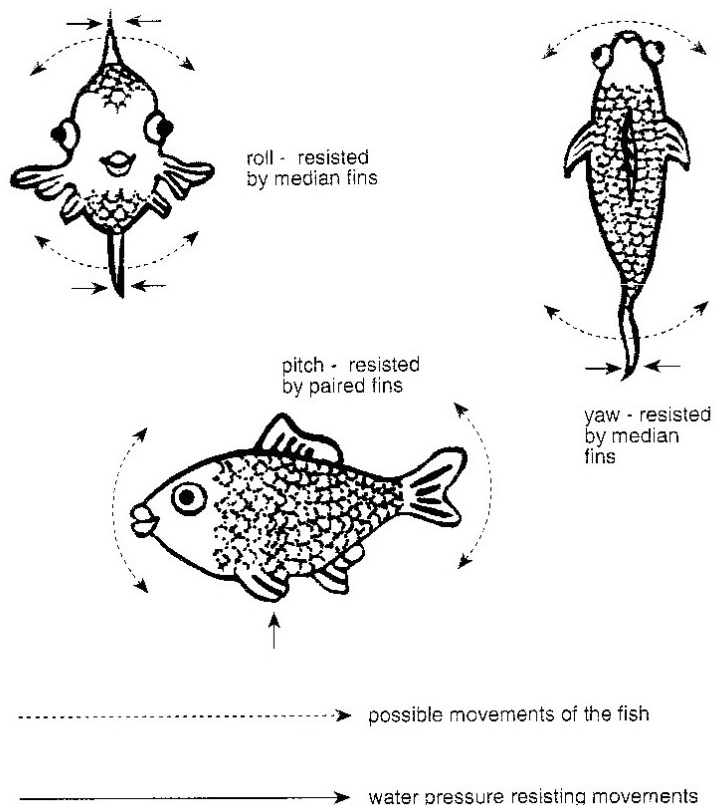
Ventral fin – Serves to provide stability in swimming.

Caudal fin – In most fish, the Caudal or tail fin is the main propelling fin.

Anal fin – Also lends stability in swimming.

Pectoral fins – Locomotion and side to side movement.

Adipose fin – Stability.



Scales

The deeper place dermis of the skin is made up of connective fibroblasts, collagen and blood vessels. The scales of a fish lie in pockets in the dermis and come out of the connective tissue.

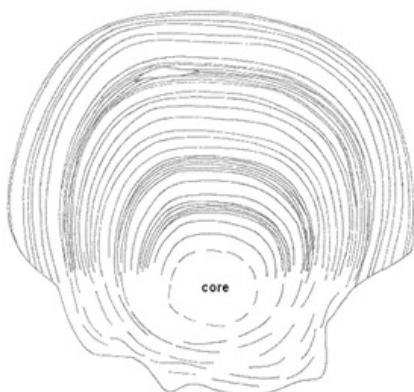
Scales do not stick out of a fish but are covered by the epithelial layer. The scales overlap and so form a protective flexible armour capable of withstanding blows and bumping.

There are two main types of scales, both are round, but in one the edges are serrated and the other are completely smooth. In the Mailed Catfish the scales are replaced by bony plates. In some other species there are no scales at all.

Scales protect the fish from its environment. They overlap like shingles on a roof so that the skin of the fish is not exposed. As a fish grows, their scales produce "rings" much like a tree - and that is one way scientists can tell how old a fish is.

Most fish get extra protection from a layer of slime that covers their scales. This slime helps them move through the water better, (which also forms a barrier to bacterial infections) and keeps pests off of the fish skin.

Look at the image of the fish scale below, like a tree, scales show rings that indicate periods of growth.



Rings that are farther apart occur when the fish grows well and there is lots of food - in the summer season.

Rings that are close together occur when the fish does not get much food and grows slowly. On the scale you can identify the summer growth and the winter growth. (There will be several rings in each).

The core represents the fish when it was first born, as a fry. The rings near the edge are the most recent periods of growth.

Pigment (colour) Cells

The many colours and patterns seen in many fish are produced by cells in the dermis. These cells are named for the pigment they contain.

Melanophores – Brownish-Black pigment called Melanin.

Erythrophores – Red pigment.

Xanthophores – Yellow pigment.

Iridophores – Contain crystals which refract and reflect light, given many fish their metallic look.

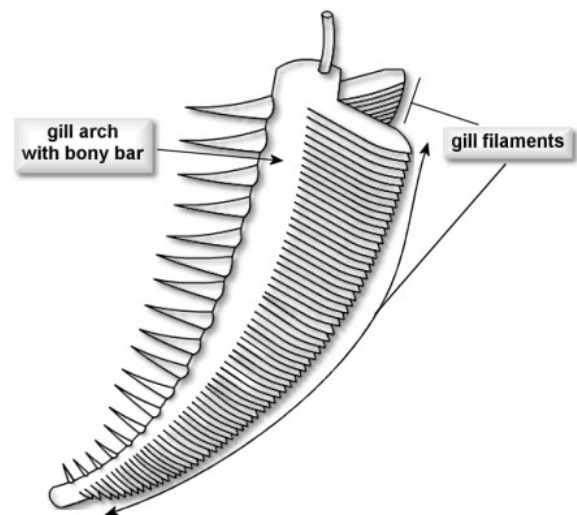
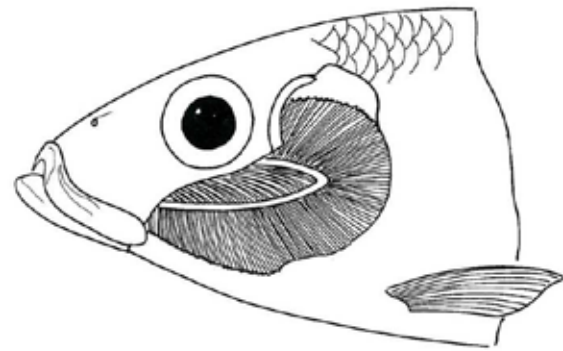
Fish can change colour from one moment to the next. This is caused by the movement of Melanin grains within each cell.

When dispersed, they absorb more light and the area of the fish darkens, when tightened the fish goes pale.

Gills

Respiration is carried out by means of gills located under the gill covers. The walls of the Pharynx is perforated by five slit-like openings. The tissue between the slits is called the Gill arch, so on each side of the fish there are five Gill Slits and Four Gill

Arches. On the Gill Arches are mounted the actual Gills; a delicate system of blood vessels covered by a very thin Epithelium through which the gaseous exchange takes place.



Skin

The skin of fish is divided into two layers, the Epidermis (outer) layer and the Dermis. The Epidermis is made up of epithelial cells, arranged one above the other. These cells are constantly shed and replaced with new ones.

Inter-spaced between the epithelial cells are slime cells, which produce mucoid secretions that form the very important protective covering, we know as the slime coat. The dermis lies under the epidermis and many important functions happen there.

The streamlining of the fish is carried over to the skin, which probably fits more closely than the skins of other vertebrates. The skin is a relatively impervious, tough and elastic protective covering. This protection is even more effective because of the scales characteristic of fish (the absence of scales in some species can be regarded as a special development). Scientists can age some species of fish by counting the 'annulus' or year-mark on scales.

The skin holds certain sense organs, numerous glands, and colour cells responsible for the intricate patterns many fish display. Also a waste product called guanin is deposited on the skin and because it can reflect light produces white, silver or occasionally iridescent effects.

Skeletal System

The skeleton of a fish may consist of actual bones or may be cartilage. The major divisions are: the backbone and associated structures (ribs, unpaired fins and tail); the girdles (pectoral and pelvic) and attached paired fins; and the skull, including the supporting structure of the gill cover.

Did you know that the loss of a scale, or exposure of the skin through removal of the protective slime coating, through attack by another fish or by rough human handling, is the equivalent to a third degree burn in humans.

Always handle your fish with the utmost care for the shortest possible time. Keep them immersed whenever possible and always ensure your hands are wet before and while handling them.

The skeleton supports the body, affords protection (the cranium protects the brain and the vertebrae protect the spinal cord), offers surfaces for attachment of muscles, and provides leverage for movement. Because of the supporting effect of water the last two functions are of less significance among fish than among terrestrial vertebrates.

Musculature

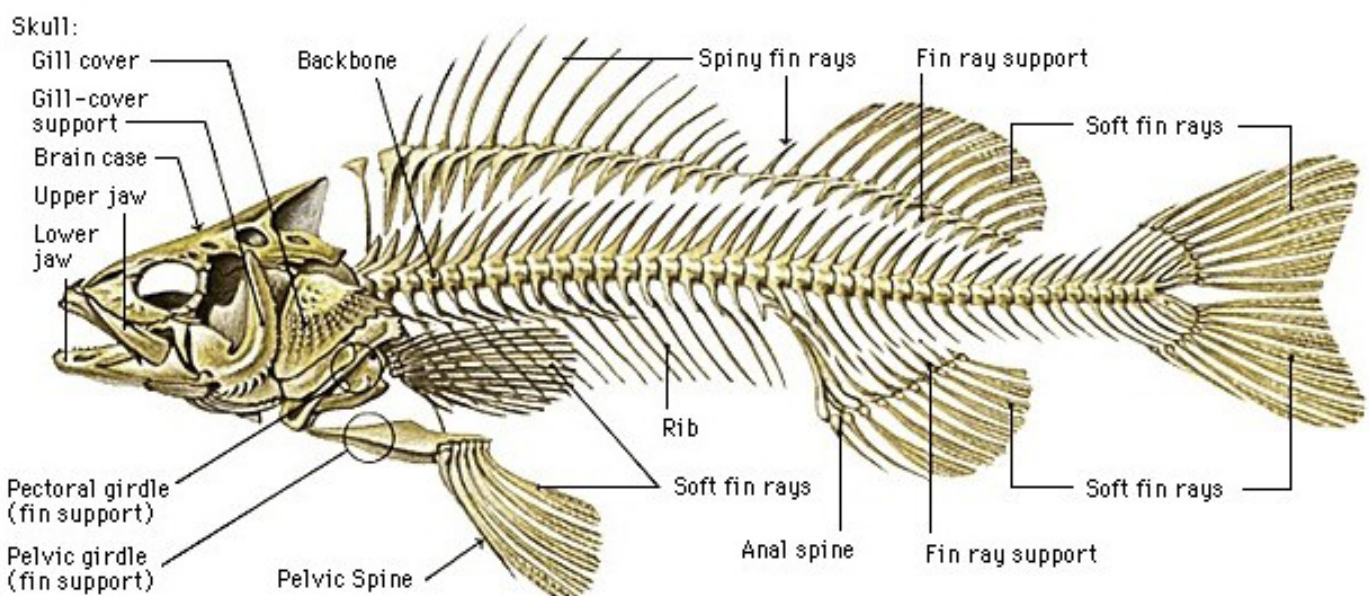
The absence of such complicated appendages as legs and wings allows fish to have a primitive arrangement of muscles down each side of the body in a series of definite and similar segments. In

most fish these vertical segments are divided into dorsal (upper) and ventral (lower) sections by the lateral line.

Fish also have various specialised muscles such as those which move the jaws, gill covers and fins. Also there are so-called 'smooth' muscles that are essentially part of certain organs (the wall of the digestive tract for instance), and the cardiac muscles of the heart.

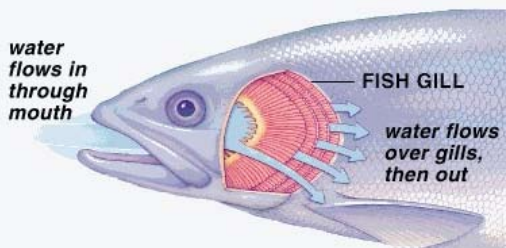
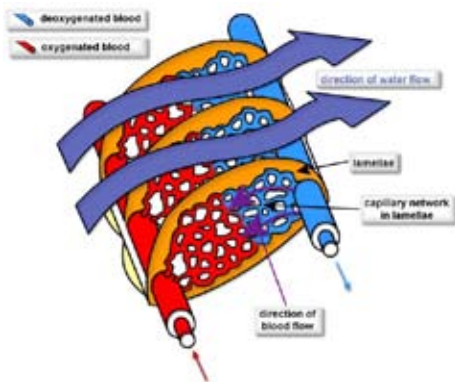
Respiration

Most fish get their necessary oxygen through gills. Each of the gill filaments, which are attached to the outer curve of



the gill arches, is richly supplied with blood vessels.

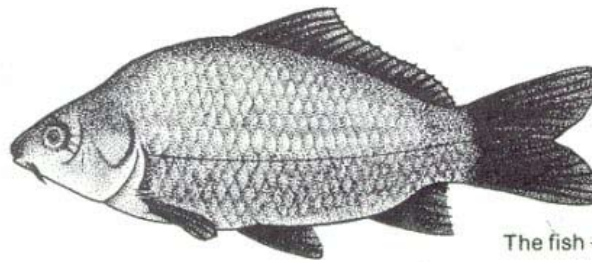
As the water passes over the gills, carbon dioxide and other wastes are discharged from the blood and oxygen dissolved in the water is absorbed into the blood stream through the delicate membrane of the filaments.



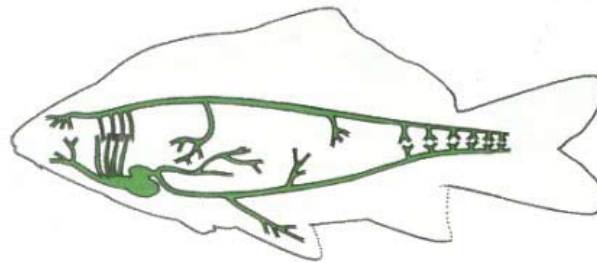
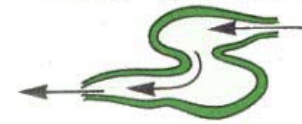
Circulation

In the higher vertebrates two chambers of the heart (one auricle and one ventricle) are concerned with pumping blood from the heart to the lungs and two with distribution of the oxygenated blood to the various body parts.

However fish get by with just a ventricle and auricle. The blood is pumped forward by the heart to the base of the gills, passes through the capillaries of the gill filaments, and is then distributed to the body tissues through arteries and capillaries. Blood collected by other capillaries returns to the heart through the veins.



The fish — 2-chambered heart



Digestive Tract

The digestive system consists of the mouth, gullet, stomach, intestines, pancreas and liver. Size and position of the mouth vary widely with the feeding habits of the fish.

Bottom-feeding fish have a mouth turned downward. When the main food is found in the open water the mouth usually is terminal (pointing directly forward). If a fish feeds mainly on the surface the mouth may slope sharply upward (as in the spotted barramundi or saratoga).

Shape and spacing of the teeth also vary. Predatory fish usually have numerous, strong teeth on the jaws, as well as other parts of the mouth and pharynx. Some species have teeth shaped for crushing or grinding and others have no teeth at all.

Collection of food is helped in some species by the gill rakers (attached to the inside curve of the gill arches) which are modified to form a comb-like structure that strains small particles from the water.

The rest of the alimentary tract is straightforward, except for the tube-like

sacs attached to the stomach near its exit. These are called pyloric caeca but their exact function is unknown. Some fish have none at all while others have considerable numbers (the mackerel has nearly 200).

Reproductive Organs

The ovaries (one or more commonly two) in the female fish lie in the upper part of the body cavity, more or less parallel to the kidneys. In most fish the eggs are first discharged into a hollow central cavity of the ovary and then passed to the exterior through special ducts.

In certain fish which bear live young (sharks, for instance) the terminal position of the ducts may be expanded to accommodate the developing offspring. In other viviparous fish (such as mosquito fish) the young develop in the ovary itself.

The number and size of eggs vary enormously from species to species. Pelagic fish that spawn in the open sea produce the most. Nest builders usually produce fewer eggs than 'wild spawners', while in viviparous species the number may be small (only 4 to 14 eggs for one of

the rays). Eggs of the pelagic fish are naturally small but in some sharks they are bigger than ostrich eggs.

The testes of the male fish are in a similar position in the body cavity to the ovaries of the female and like them have special ducts to take the sex products from the body. Males of viviparous species have special organs (developed from the pelvic or anal fin) for internal fertilisation of the eggs.

Smell

The olfactory organs consist of deep pits lined with special tissue. The size and position on the head of these organs vary widely. The use of this olfactory sense varies not only with the species but also with the conditions.

English experiments showed that "Pollock" that were not particularly hungry usually smelt food before taking it. However when ravenous the same fish bolted down clams soaked in such

obnoxious substances as turpentine and chloroform.

Sight

General structure of a fish's eye is similar to that of other vertebrates. However there are certain modifications for seeing under water. The outer wall of the eye is flatter in fish than in land vertebrates. The lens itself is much more rounded.

Fish focus their eyes not by changing the shape of the lens (as terrestrial vertebrates do) but rather by shifting its position.

There is evidence that fish are comparatively near-sighted but experiments have proved they can distinguish colours. Eyes tend to be small and inefficient in species that live regularly in turbid water and may be lacking altogether in fish in underground waters.

Hearing

In fish and other vertebrates the ear is an organ of equilibrium as well as hearing. The part concerned with hearing lacks the intricate internal structure found in higher vertebrates. This and supporting experimental evidence suggest fish do not hear at all in the ordinary sense. Their "hearing" probably consists of little more than the detection of vibrations in the water. In many fish the ear is connected to the swim bladder by a tubelike growth from the latter or by a series of small bones.

It is possible this intensifies the impulses from vibrations in the water. Another structure that might help is the lateral line organ, which experiments indicate might be capable of detecting low-frequency vibrations (about six a second).

Taste

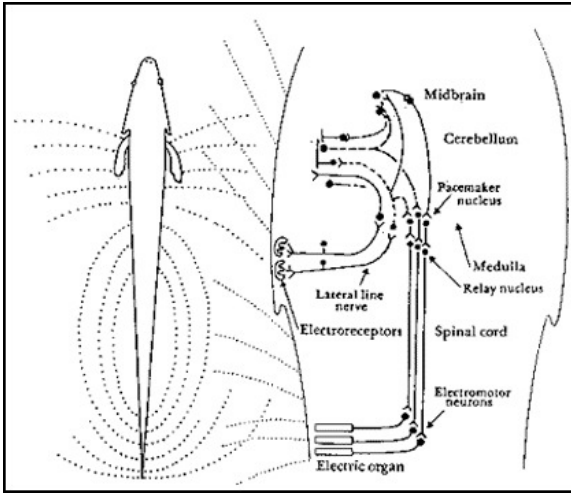
Little is known about the sense of taste in fish. In fact there is some question as to whether this sense exists in most species. Many of the taste functions are performed by organs distributed over the body, or on barbels.

Touch

Touch is probably the most highly developed sense fish possess. Sense organs in the form of buds or small pits and in contact with nerves are distributed over the entire body. They are particularly numerous in strategic positions such as the surface of feelers and barbels. The extent to which fish feel pain has long been debated. Although no one will ever know how a fish feels when hooked there is ample evidence that the experience is not disturbing enough to halt feeding activities.

It is not uncommon for fish that have escaped before being landed, or released, to take the hook again immediately





afterwards. In Australia the tailor is a prime example. Specimens have been caught with two gleaming sets of hooks already in their jaws.

The Lateral Line is how the fish “hears”. It is sensitive to pressure, vibration, movement and sound and lets the fish know what is in the water around them.

Swim Bladder

In the weightless underwater world, human divers use equipment known as buoyancy compensator devices, which allow them to maintain neutral buoyancy. These are vests that contain bladders of air that can be adjusted to allow the diver to go deeper into the water or rise to the surface.

Fish have their own built-in device called the swim bladder, which is a gas-filled sac in the abdomen that helps them to maintain buoyancy in the water. Like a BCD, the sac inflates if the fish needs to be more buoyant and deflates if the fish needs to be less buoyant.

Goldfish and some other fish are members of the cyprinid (minnows and carp) family and are physostomous, which means there is an open connection between the oesophagus and the swim bladder. The bladder is

called a pneumocystic duct, and it allows additional adjustment of buoyancy by letting air out through the digestive tract.

It was believed that before fish evolved this buoyancy organ, they would have needed to swim constantly in order to maintain their depth. Many experts on fish evolution believe that the eventual development of the swim bladder allowed fish to swim slower and become

more manoeuvrable and agile, and that these free swimming habits were accompanied by changes in body form and fin shapes, forms and function.

The swim-bladder may have developed originally as an organ of respiration; it still has that function in some primitive fish. However the swim-bladder in most fish helps them stay afloat. Sharks, which do not have a swim-bladder, sink to the

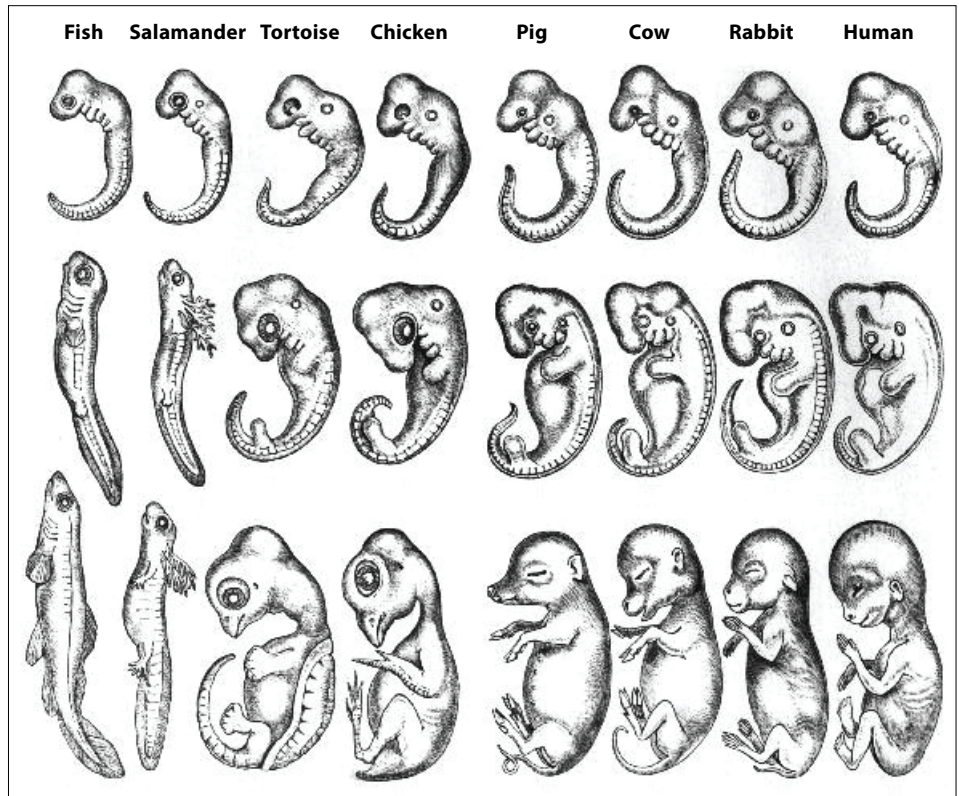
bottom if they stop swimming.

Our fish are really not so different from us – they see, taste, smell and hear – but they do it in an interesting underwater world. Understanding how your fish relate to their world will help you provide them with the best care.

Perhaps we should ask, just how different are we really from fish, our evolutionary ancestors?

Perhaps not that much when you look at the early embryonic development of various species. ●

Have you ever wondered how your fish seem to know when you're coming to feed them? Next issue we'll look at the question of "fish sense" – or at least fish senses.





FAST, or Faith And Sustainable Technologies is a website started and run by Travis Hughey. Travis has been involved in aquaponics for many years now and he has been one of the pioneers in using plastic barrels to build aquaponic systems. He wrote the "barrelponics manual" which he released as a free download for everyone.

Travis spent some time in Kenya last year helping the locals to learn about aquaponics, and in May 2008 an aquaponics workshop was held at his property in South Carolina, and he plans to run workshops on a regular basis in the future. There's a lively discussion group at the barrelponics discussion forum, with people from all around the world involved in discussions.

You can check out the website at www.fastonline.org



FRESH BY NATURE



We can supply complete BYAP Kit Systems fully installed and working or a full range of BYAP Products for you own installation

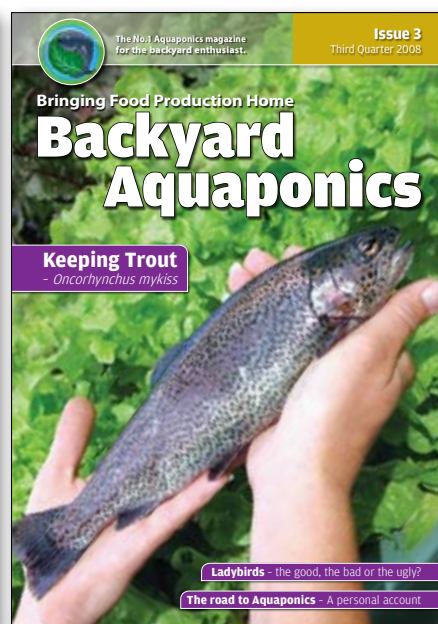
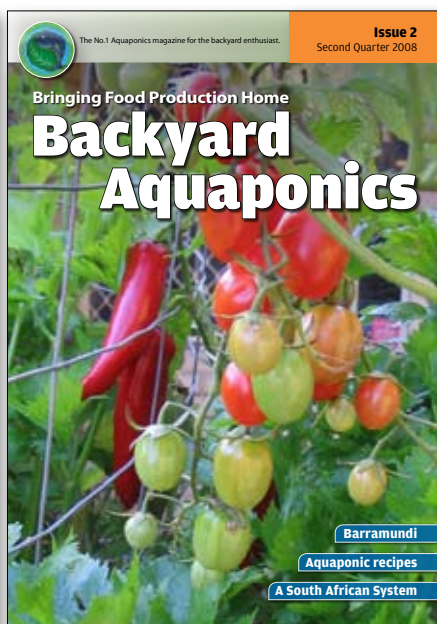
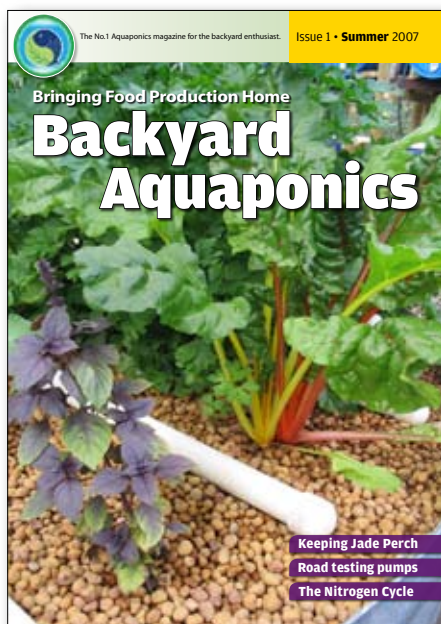
Authorised NSW Distributor of BYAP Systems and Products



We have access to a wide variety of aquaculture stock, stock feed, tanks, bio-filters, nets, scales, water quality tests and meters, microscopes and laboratory equipment.

We also carry, or can supply, a vast range of hydroponic products to meet your every need... NFT equipment, nutrients, grow media, trays, pots, lights and much more.

Visit us at www.freshbynature.com.au or email us at info@freshbynature.com.au



Backyard Aquaponics Magazine

Future Editions and Subscriptions

Work is well under way on the **fourth edition** of the magazine. We will be showcasing more systems that belong to members of the online discussion forum, there will be information about fish feed and fish diseases, and we'll have an in-depth look at another fish species suitable for use in aquaponics systems. One of the new items to look forward to in the next issue, is a **question and answer** section where we will take some of the most commonly asked questions about aquaponics and provide you with straightforward answers from experienced aquaponic system operators.

It's promising to be an exciting issue, packed full of information, pictures and diagrams and we hope to see you then.

**Issue 4
OUT
SOON**

The **Backyard Aquaponics Magazine** can be purchased and downloaded from the Backyard Aquaponics magazine website either as individual issues, or as a yearly subscription. Alternatively, we can mail you a copy of the magazine on CD-Rom, or DVD.

If you have any queries, please don't hesitate to contact us.

Backyard Aquaponics

PO Box 3350, Success.

Western Australia, 6964

+61 (08) 9414 9334

magazine@backyardaquaponics.com

