Fish Hatchery Management

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- Aquatic organisms (fact sheet)
- Modes of fish reproduction
- Naturally collected fry/broodstock
- Sexual maturation and broodstock management
- Fish hatcheries and hatchery technologies
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Aquatic organisms (fish)
Introductory fact Sheet

- Cold Blooded Animals Except a known species (Great white shark)
- Highly fecund animals (regardless?)
- Highly diversified group (finfish, crustaceans, molluscs, …)
- Vary significantly in regard to the mode of their reproduction
- Living environments determine types of fish inhabiting and reproducing in such waters (cold water, warm water, freshwater, marine water)

Modes of fish reproduction

Egg layers - examples

Substrate spawners

Prawn carrying eggs

Oviparous

Majority of fish

Mouth brooders

Egg retainers

Ovoviviparous

Each embryo develops in its own egg in female's body until hatch. Embryos depend on their yolks

Live bearers

Viviparous

mother retains the eggs and nourishes the embryos till they are born

Egg layers and parental care

No parental care: fish freely lay their eggs and sperm and then abandon the eggs (e.g. Atlantic herring, tilapia zillii)

Modes of parental care:

- Nesting and guarding: (e.g. Nile tilapia, channel catfish)
- Fanning egg masses (e.g. channel catfish males)
- Mouth incubation: (e.g. Nile tilapia females)
- Guard young after hatching (e.g. bowfins males)

Passive care & special arrangements: (depending on species):

- Hiding eggs
- Eggs have oil droplets that help them float
- Some bottom-dwelling fishes produce eggs that sink
- Some eggs may be sticky that allow them to attach to objects

Parental care

Spawning nest (tilapia)

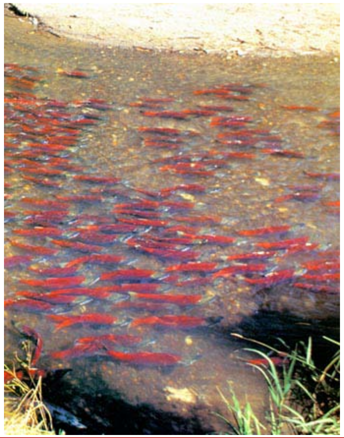
Copa female holding fry

Fanning egg mass
(channel catfish male)

Protomelas sp.
(taking fry in)

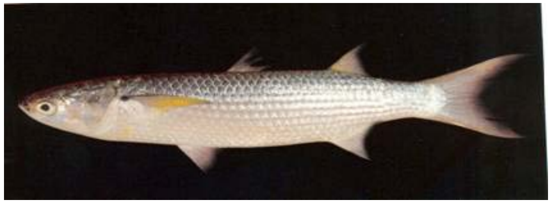
Organism and spawning runs & last stops

Eels
Sargasso Sea (last stop)
catadromous



Salmon
Rivers (last stop)
anadromous

Mullet
(no last stop)
catadromous



Spawning migration (eels)

- About 700 species of mature freshwater eels **(age of 15 years)** undertake a remarkable migrations; starting from rivers and streams of Europe and North America to the Sargasso Sea (their birth place), North of Atlantic Ocean whereas strong currents and gentle winds prevail
- After spawning, mature eels die there while hatched eels (elvers) quickly leave this region and swim to the rivers of Europe and America
- Theories – no facts – in regard to the ability of little fish to carry out their return trip to the home of parents (6000 km long)

Few of many questions

Why such long trip adults undertake to breed and die while there are many places closer?

How & why newly hatched eels go on a long and tiring journey with no guidance against the currents to the region their parents came from, instead of remaining where they are?

- **Source:** The miracle of migration in animals

Fecundity and reproduction behavior

In general, the number of eggs/offspring is inversely related to the chance a single egg has to reach maturity and reproduce

Hence, species whose eggs have little chance to reach maturity lay the most eggs (could reach millions) in contrast with mouth brooders such as tilapias whereas eggs are in hundreds or few thousands while live bearers such as guppies often produce less than 25 young at a time

However, within a species, fecundity according to many factors including age, size, food availability, species, season, and water temperature

Fecundity needs to be described whether absolute (number of eggs/female in a spawn/year/life time), or relate that to gram of body weight of a female

Mother Nature

Fry/gravid female collection

Milkfish

Black tiger shrimp

Mullet fry

Mullet

Done in Case of:

Abundance

No hatcheries

Reproductive cycle is not closed - eels)

Economic reasons

Continuous debate between fisheries and aquaculture

Disturbing mother nature

Human activities (over fishing)

Pollution (mass/selective effects)

Political conflicts (sturgeon & shared stocks)

Construction of dams (block migration)

Fish ladder?

The establishment of hatcheries
became necessary
for aquaculture development

Hatchery Management
ONE SHOULD REMEMBER

- The collection of wild fry could be more economical **BUT** has its limitation.
- Advanced technology can only be applied through artificial spawning in hatcheries.
- The role of the hatchery is very different from farm (Numbers of appropriate size).
- Water temperature and light are very important in hatchery practices (fish are cold blooded animals).
- Therefore, optimum range for reproduction falls **<u>within</u>** survival range.

Hatchery Broodstock

- Sources (wild – farm or hatchery)
- Domesticated versus wild

To be covered in the lecture on genetics

- Efficiency under different environments (GxE)
- Not passing through genetic bottlenecks
- From maximum number of spawns
- Good understanding of effective breeding number N_e

Broodstock from the wild

Why? and when?

For First time ever

For stock enhancement programs **(release) (Fish for natural systems are not the same for aquaculture)**

Does not mature in captivity **(until now)**

Hatchery facilities cannot handle the full operations

Economic reasons

BUT:

Less Reliable & not economical anymore
(shrimp – Iran - Thailand)

Cannot perform breeding programs

Broodstock **(From other hatcheries or farms)**

More reliable

More domesticated (if needed for aquaculture)

Possible application of breeding programs

Possible conditioning for extended spawning seasons

Better understanding of broodstock history (depending on the quality of book keeping system)

Replacing hatchery broodstock

Facts:

Young broodstock produce more eggs/g, with shorter spawning interval and much easier to handle. Replacing broodstock may be recommended as required

No Fixed Rule

Conditioning after spawning before bringing them in

OR

Annually change 33%

OR

All-in & all-out

Compensating the missing sex to correct for the skewed sex ratio (in fish changing sex – e.g. gilthead seabream when males change into females)

Broodstock Maintenance

Overwintering

Taiwan (tilapia)

Italy (fence – warm well)
Seabass & seabream

Feeding

Overfeeding with carbohydrate rich or fatty diet **to be avoided**

Cases showed that visceral fat in Indian carps and grass carp affected ovaries development and hence no response to hormonal injection

Placing fish in weedy habitats helped in shedding visceral fat and fish spawned

Mixing squids to the artificial feed of marine broodstock is believed needed

Broodstock – ponds/tanks

Ponds

Sufficient number will help avoid too many fishing and so reduce stress and possible decline in the potency of fish

Good match between outdoor ponds and indoor facility should be secured

A recovery pond for spent females is a must

Depending on hatchery plan, a pond for common carp may be considered (donor to pituitary gland)

Tanks

Neither material nor paint should carry any harm to broodfish

Water flow should be adequate to fish biomass (not excessive)

Design should allow self-cleaning

Tanks are either covered or enough free board should be secured

Air supply from oil-free air pumps

Hatchery Management – Water

Quantity

For freshwater hatchery
Ponds of 5-ha require 40-50 l/second of water

For marine hatchery
Pumping capacity/h 50% of water volume

Quality

Hatchery water should be:

- **L**ow in turbidity
- **H**igh in DO
- **L**ow in CO_2
- **Extremely low** in hydrogen sulfide **(if any)**
- **N**ot super-saturated with nitrogen other gases
- **Salinity (level & range)**: close to optimum
- **Temperature**: close to optimum with minimum fluctuation
- **Heavy metals**: case by case

Water Quality

Turbidity

Sand filter – oyster hatchery Morocco

Suction pump – backyard prawn hatchery – Thailand

Sterilization

UV system – oyster hatchery Morocco

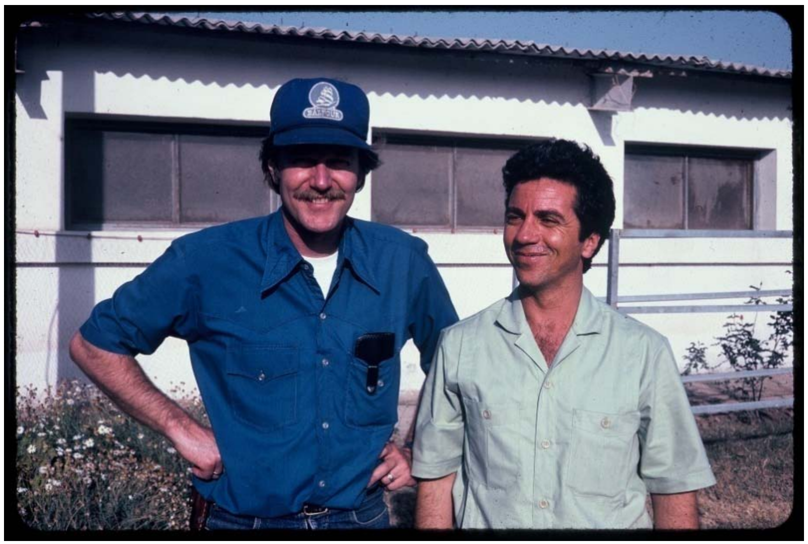
We need to consider:

What could be accepted in a farm may not be tolerated in a hatchery

Copper and Zinc are damaging elements (no copper pipes, no zinc containers)

Hatchery management

Started complex (Egypt case)



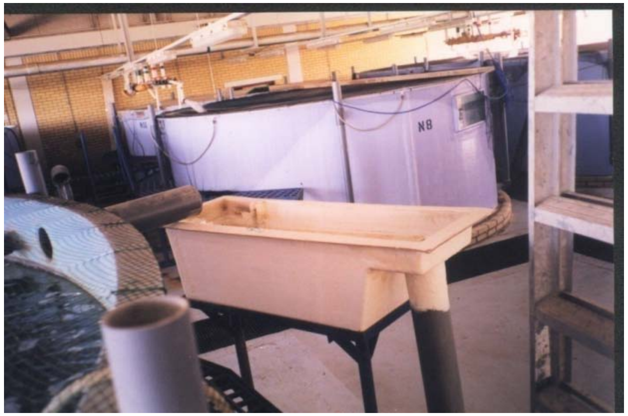
1980 – Abbassa (common carp)

1982 – Sète/France
(seabass, seabream)

Hatchery management

Turned easier- more towards natural systems

Open spawning system
Marine hatchery - Cyprus



Egg collection system
Marine hatchery - Kuwait

Hapa system
Tilapia hatchery - Egypt

Management concept

Usually apply to large hatcheries

Abbassa

Aswan

Management concept

Should also apply to small hatcheries

8 million tilapia fry

2 million tilapia fry

Broodstock
Gonad Development

- Gonads develop to a certain stage and remain dormant
- Further development will be triggered as suitable conditions exist producing ready to spawn
- Dormant stage continues if environmental changes are not too strong
- If environmental conditions gets worse, absorption of eggs takes place

Sexual maturation

Several factors –other than triggering factors- influence the age at sexual maturation. Such factors include species, age, gender, and size

Most bony fishes become sexually mature between **one and five years**. However, some species may require longer periods to become sexually mature; eels (family Anguillidae) and sturgeons (family Acipenseridae) may require up to 15 years to become sexually mature

In general, species of a small maximum size begin reproducing at an earlier age than those with a large maximum size

Trigging factors: include:

Changes in the duration of sunlight, or photoperiod

Temperature change may trigger the maturity of fishes in temperate areas

Others such as the presence of the opposite sex, currents, tides, moon stages, and presence of spawning areas

Salinity influence sexual maturation of many of marine fish

Triggering environmental changes

(e.g. salinity & gilthead sea bream/EU sea bass)

- Gonads may start to develop in water with a salinity lower than 35 g/l, such as in the case of estuaries and coastal lagoons.
- Final steps leading to maturation **would require** full seawater (= 35 g/l).
- Temperature would always have an effect on the speed of gonad development.
- Spermatogenesis (development of sperm) can take place under captivity conditions and even at salinity levels lower than full seawater.

Broodstock sorting

Sorting (based on gonad development)

Females:

- Ripest (ready to spawn)
- Promising
- Not different from males (discard)

Males:

- Ready
- Unready (discard)

Determining Sexual Maturation

Roughness of the upper surface of pectoral fins (sand paper touch) is a sign of male maturation (grass carp)

Can be easy

Determining Sexual Maturation

My require additional work

Fish in the spawning run/grounds must be sexually mature

Ultrasonic practices may be required

Egg sampling
a common practice with many fish species

Hatchery technologies

Chosen reproduction mechanisms is determined based on:

- Specific to species requirements (why there is no tilapia artificial hatchery?)
- Facilities available
- Economics

Hatchery technologies could be:

Natural: Tilapia, common carp, African catfish

Some artificial: Tilapia, some marine species, shrimp, others

Artificial: Chinese carps, common carp, some marine species, African catfish, others

Natural Systems

Sticky eggs of common carp

Our responsibility:
Choose the ready broodstock
Choose the right time
Furnish the required facilities
Watch for the spawning

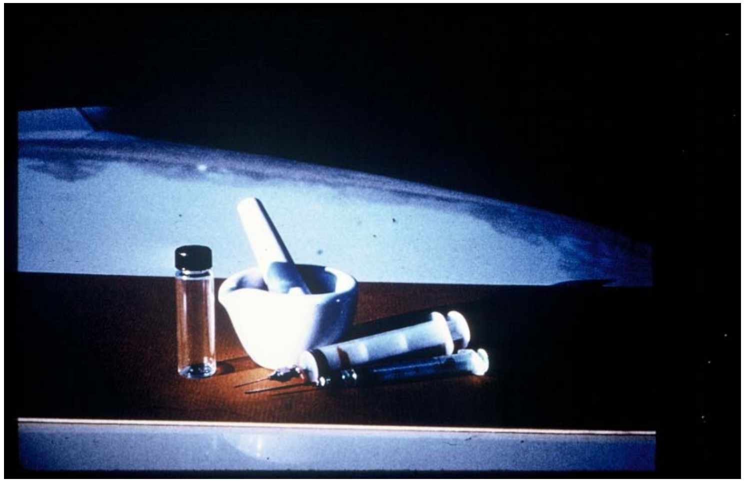
Fish responsibility:
Get the work done

Seabass open system

Mating place - channel catfish

Tilapia

Artificial Spawning



Biological parameters still controls

A broodstock must be ready in order to respond to induction practices

Artificial Spawning
(related to hormonal injection)

Hormones used for induced spawning **<u>do not produce</u>** eggs or sperm (gametes)

Hormones only trigger the release of fully developed gametes

Fish must not only be sexually mature but also in the advanced stage of sexual development before induced spawning will be successful

Sources of hormones could be the pituitary gland or other hormones (e.g. HCG, LHRH)

Source of pituitary gland

Common carp
Donor to many species

Or: Species specific

Why common carp?

Pituitary gland

First used in 1934 in Brazil

Should be taken from sexually mature male or female

Will be more effective when taken just prior to the spawning season

One kg of common carp has a pituitary weighs 3 mg dry weight (usually used by count)

Administration of hormones & fish

IF:

Fish are selected properly **and**

Hormones are administered at the right timing and dose

↓

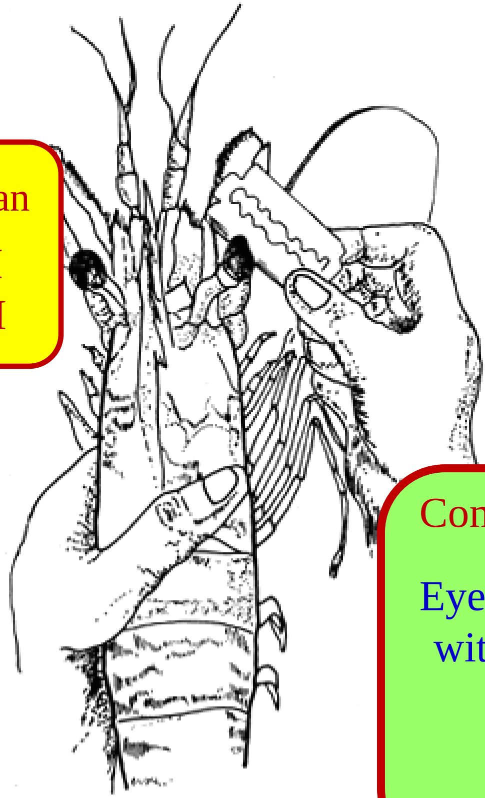
Ovulation is expected

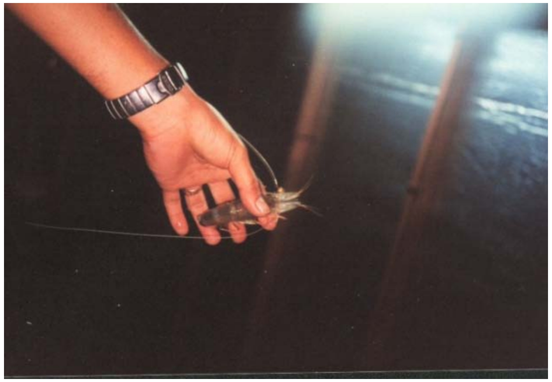
Full Spawners or Batch Spawners?

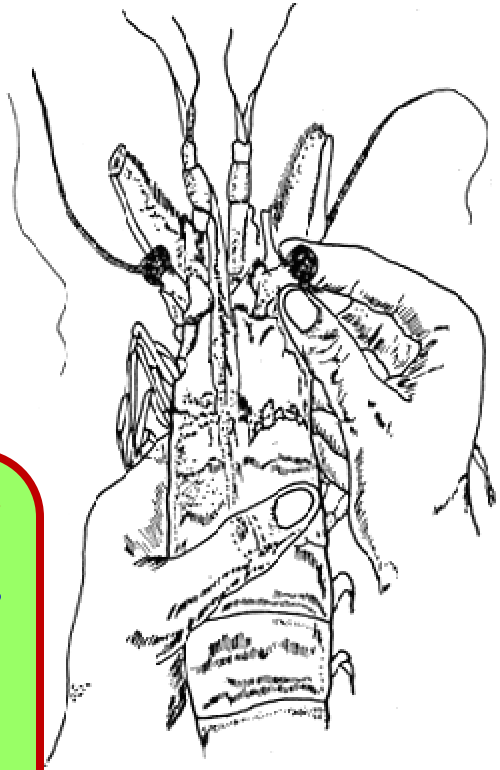
Specific hormonal induction & eyestalk ablation

X organ

GIH
MIH







Commercially adopted in the early 1970s

Eye stalk ablation removes x organ along with "Gonad Inhibiting Hormones" and hence stimulate the final gonad development

Hopefully one eye stalk

Incision

Source: FAO, shrimp hatchery, design, operation and management

Press

Ripening – (fish are cold blooded)

Ripening period (time between final hormonal dose and ovulation/stripping): e.g. Common carp:

Temperature (c)	Ripening time (hour)
15-16	24-26
18-19	15-16
22-23	12-15
25	10
28	08

Ovulation

- Time of ovulation need to be watched
- Indicator fish may tell
- If eggs were not stripped at the appropriate time it turns overripe
- Over-ripe eggs do not fertilize
- Time between final injection and ovulation is ripening time (hour-grade)

Ovulation & stripping

African catfish eggs

Colossoma eggs

Before ovulation

Fertilization

After the completion of fertilization, (dry or wet method), fertilized eggs (embryos) should be incubated till hatching

Good quality milt
=
High rate of fertilization

One male or more?

Preserving milt

Incubation – duration & facilities

Affected by:

Species

Type of eggs

Environmental conditions

Key environmental factors are temperature and light

In general, incubation period could be as short as few days for some species or as long as several months for other species.

Incubation period (examples)

Selective warm water species

Source: FAO

Species	Incubation temperature (C)	
	Optimum	Days/hours
Common carp	20 - 22	3.5 - 4 d
Grass carp	22 - 25	1 – 1.5 d
Catla	24 - 30	14 – 20 h
Asian catfish *Pangasius sutchi*	28 - 29	23 – 25 h
Nile tilapia	28	4 d
Clarias macrocephalus	26 - 30	18 – 20 h
Cachama *Colossoma oculus*	25 - 26	18 – 19 h

Incubation & temperature

Source: Earl Leitritz, trout & salmon culture

Temp C	Incubation period (days)		
	Rainbow trout	Brown trout	Nile tilapia
1.7		156	
4.4	80	100	
7.2	48	64	
10.0	31	41	
12.8	24		
15.6	19		
24.0			5-6
28.0			4
30.0			3

Types of fish eggs in relation to:

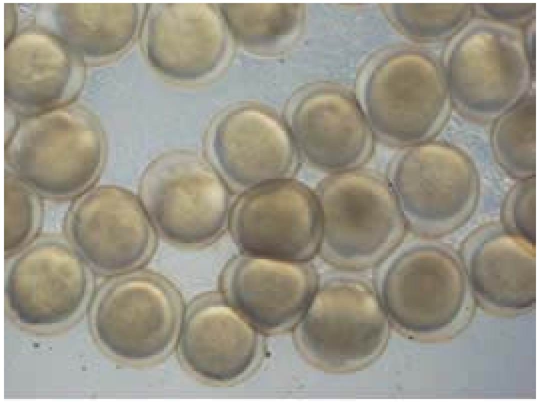
incubation or treatment

Mass (Channel catfish)

Salmon eggs

Loose Eggs (tilapia)

Sticky eggs (carps) Tannin is used to dissolve the adhesive material



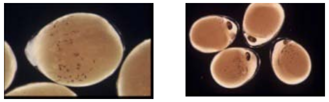
Incubators in relation to types of eggs

Embryonic Developments

Never mix different ages during incubation

Advanced development

Tilapia



Green eggs

Freshwater prawn

Good or Bad Eggs

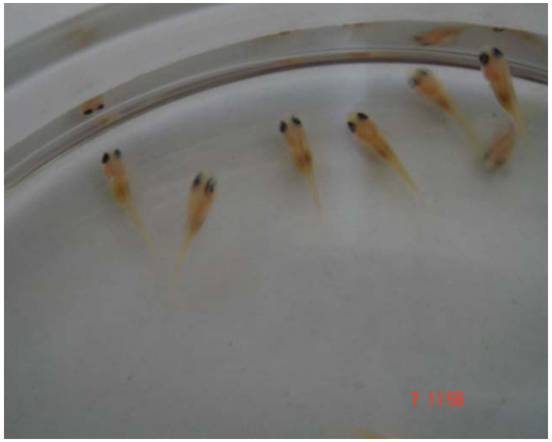
If eggs are heavily infected with fungus
And other batches could be obtained
Discard the bad batch

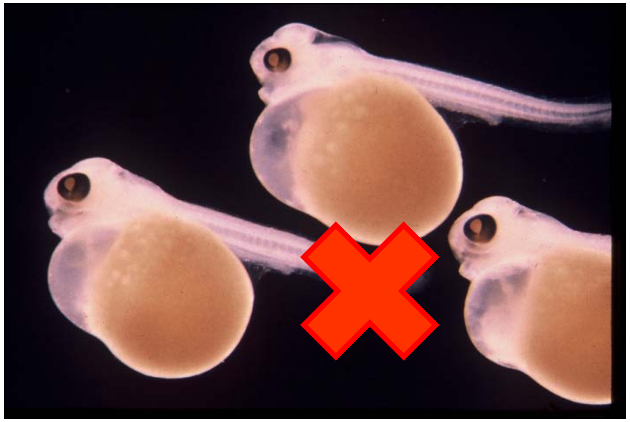
Incubation/Temperature

It is much safer to incubate at highest safe temperature

(refer to an earlier table)

Hatchery Products (good <u>or</u> bad)





Early nursing

Water temperature is the most important single factor

Temperature range is acceptable; severe fluctuation should be avoided. (some species cannot tolerate temperature fluctuation that exceeds **0.5°** C/day (seabass, seabream)

Light regime is critical for some species

Nursing (the right of young)

No matter where a larvae
Stays or moves
Its food should be there

Feeding ratios do not apply during early nursing – instead, Food concentration

The onset of the first larval feeding is a crucial step in the young fish life as starvation is a major cause of larval mortality

Management & species

While management may apply to almost all species

Because in biology nothing is exact

Modification in hatchery operations may take place according to species

Some steps may be omitted, others may be added

In brief, study your species

Extending the spawning season

Green houses helped to produce tilapia at the time suitable to farms (Egypt)

Chilling, heating and light manipulation are used in marine hatcheries (Italy)

- Manipulating of photoperiod and temperature are the key factors for extending the spawning season outside the natural season
- The technique is successfully has been successfully applied to both several fish species and is now a current practice.
- This could allow seed production year round according to marketing and/or farming needs.

Enhancing Hatchery Efficiency

Multi-species – multi-sizes - quality

Sea Bass

Sea bream

Soles

Shrimp

The same concept applies to:

Freshwater hatchers

Production of different sizes of the same species if economically visible

Screening for disease causing agents

Vaccination

Conclusion

- Hatcheries will remain a main component of aquaculture development.
- Hatcheries are not farms
- Results of hatchery products appear on the farms
- Screening for new candidates is the responsibility of national research systems.
- Hatcheries are the place of genetics applications
- Competition, economics, quality control are issues to be considered in order for the activity to remain sustainable.

Thanks for your time. I hope you have found in this presentation some of what you were looking for

While welcoming you to use the contents of this presentation, thanks in advance for referring to it

If you have any comment about this presentation or you need clarification or elaboration, I would welcome your contact via my email address

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