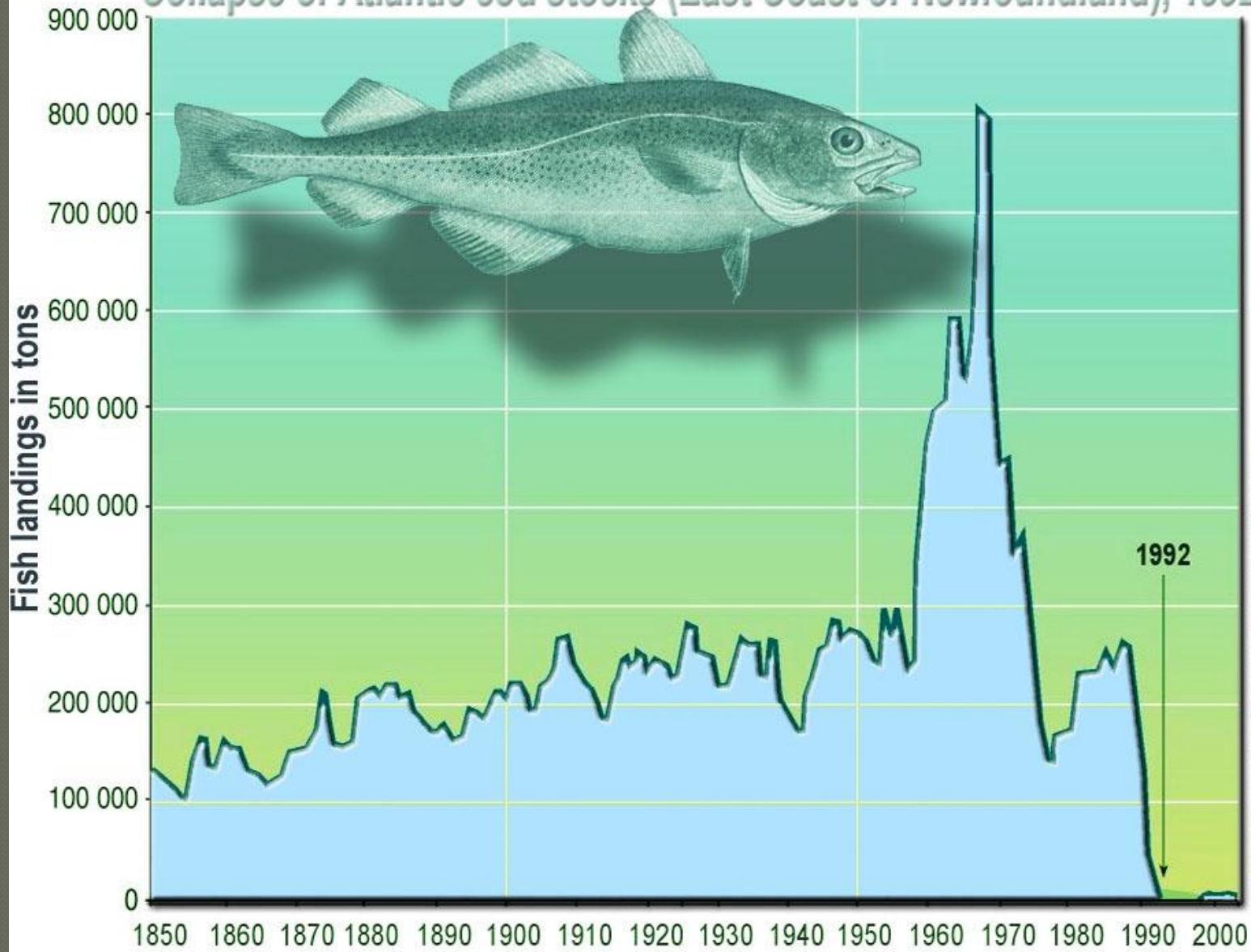


Cold Water Marine Fish Hatcheries: Production Procedures for Cod and Hake.

Gidon Minkoff. Teleostei Hatchery
Consulting
gminkoff@gmail.com

Collapse of Atlantic cod stocks (East Coast of Newfoundland), 1992.

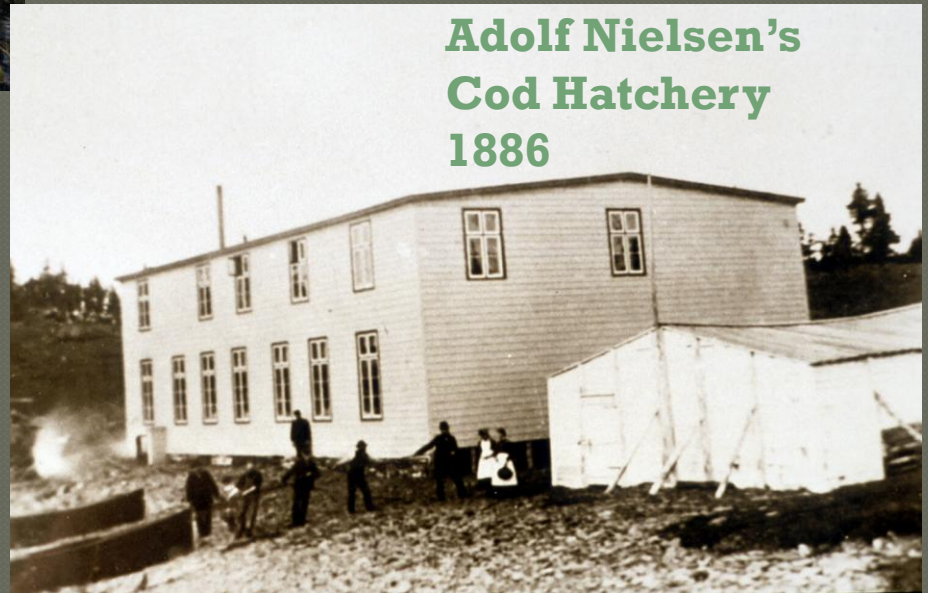


Source : Millennium Ecosystems Assessment

Early Cod Hatcheries.



Dannevig's cod hatchery in Flodevigen. Norway.



**Adolf Nielsen's
Cod Hatchery
1886**

Early life history studies

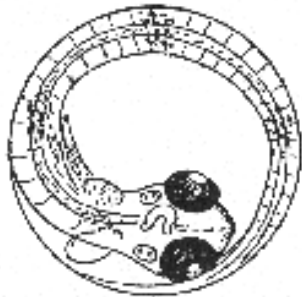


FIGURE 87.—Egg. After Heincke and Ehrenbaum.



FIGURE 88.—Larva, just hatched, 4 mm. After Masterman.



FIGURE 89.—Larva, 4.5 mm. After Schmidt.



FIGURE 90.—Larva, 9 mm. After Schmidt.

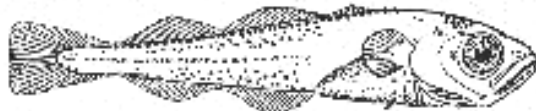


FIGURE 91.—Fry, 20 mm. After Schmidt.

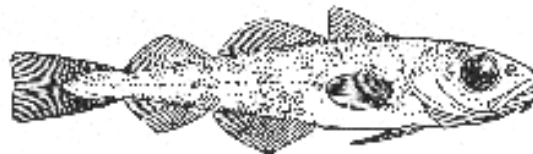


FIGURE 92.—Young, 40 mm. After Schmidt.

Cod (*Gadus callarias*), developmental stages, European.

Figure 87.—Egg. After Heincke and Ehrenbaum.

Figure 88.—Larva, just hatched, 4 mm. After Masterman.

Figure 89.—Larva, 4.5 mm. After Schmidt.

Figure 90.—Larva, 9 mm. After Schmidt.

Figure 91.—Fry, 20 mm. After Schmidt.

The Methodology

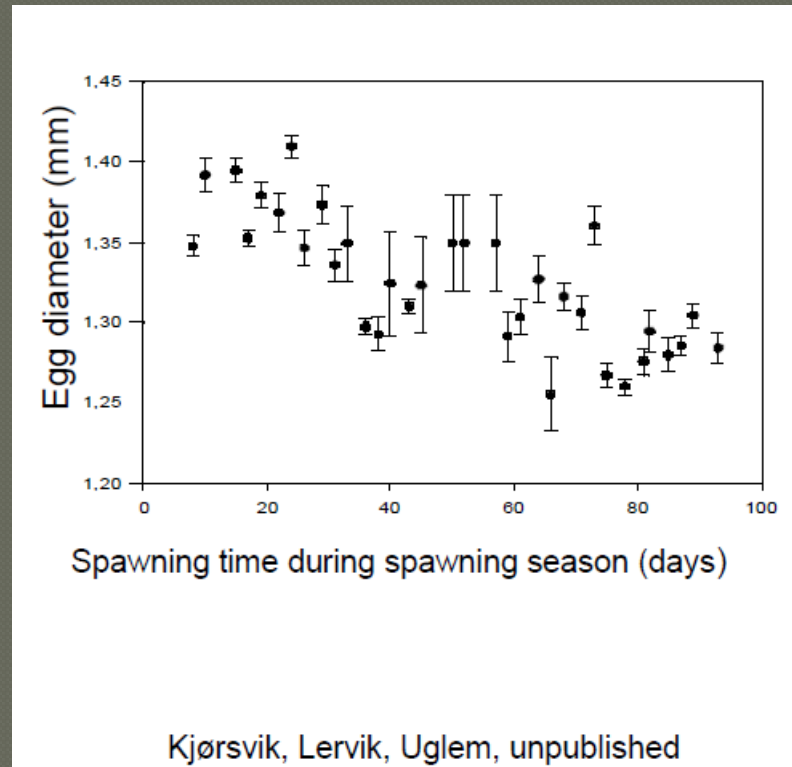
- Broodstock: domestication and spawning
- Live food production
- Rearing larvae through metamorphosis
- Transition to artificial diets

Cod Broodstock



Cod Broodstock

- Egg yield of 250-500 thousand per Kg female.
- Surface overflow collection of fertilized eggs.
- 350-500K eggs/liter



Cod Broodstock

- ◉ Temperature of 6°C
- ◉ Readily adapt to photoperiod manipulation.
- ◉ Up to 50Kg/m³ of fish in the spawning tank.
- ◉ Size range 3-15kg.
- ◉ 50/50 F/M
- ◉ Natural spawning. Tank Depth of 2m essential.
- ◉ More than 1 female spawns at a time

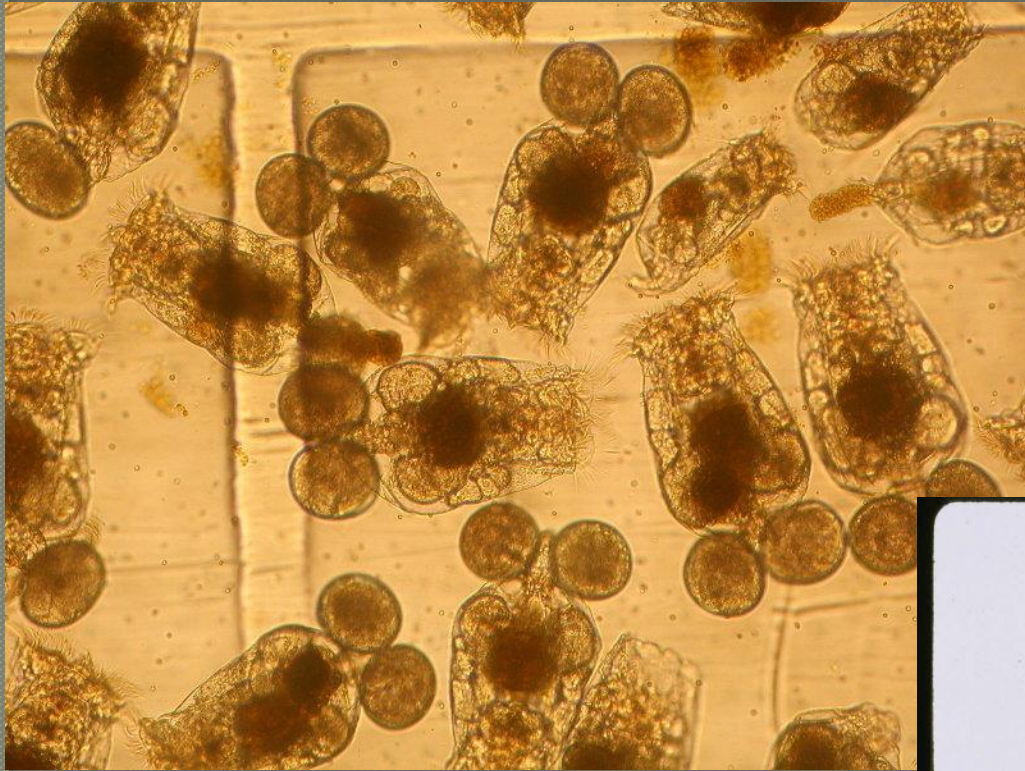
Cod Broodstock

- Elite broodstock programs in Canada and Norway.
- Major advances in gene mapping



Jonathan Moir

Live Food



Live Food Production



Live Food Requirements

- Enhancing the Dietary Value of Rotifers (Enrichments) and Artemia so that they will fit in with the dietary requirements of Cod.

- ADAPTATION TO COLD WATER CONDITIONS.

Rotifer Enrichment for cold-water fish:

1: Fish meal + DHA Selco for 17h at ambient temperature.

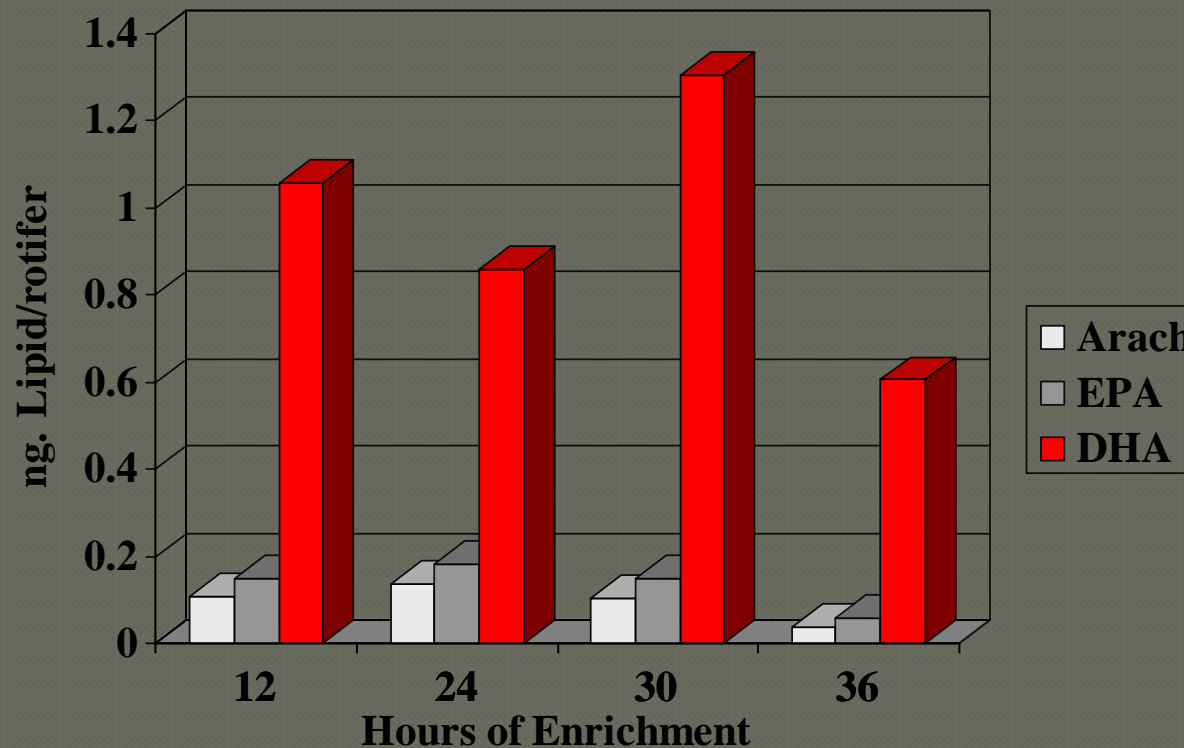
2: Algamac 2000 for 20h at ambient temperature. 3: Fish meal + DHA selco for 8h at 22°C.

Note: Ambient indicates a gradual decline from 25°C to 15°C

TABLE 5.

	1A	1B	2A	2B	3A	3B
% unknown	3.96	5.08	4.33	3.09	9.4	7.38
Saturates	24.81	25.99	36.77	35.67	28.25	22.7
Monounsaturates	35.95	34.74	30.85	31.41	37.11	40.25
Polyunsaturates	35.28	34.19	28.05	29.83	25.24	29.67
(n-3) PUFA	25.51	24.26	23.33	24.62	16.15	19.63
(n-6) PUFA	18.86	16.55	13.73	14.17	10.48	13.08
n-3/n-6	1.35	1.47	1.70	1.74	1.54	1.50
EPA	7.24	6.3	2.7	2.8	5.05	5.65
DHA	12.73	10.73	11.74	12.24	6.21	8.07
DHA / EPA	1.76	1.70	4.35	4.37	1.23	1.43
(n-3)HUFA	22.42	19.21	19.56	20.48	12.86	16.19

Algamac 2 Stage Enrichment



Cod First Feeding

- Possible from day 3ph.
- Preferable from day 5ph.
- Presence of Yolk,
- pigmented eyes,
- gall bladder green.



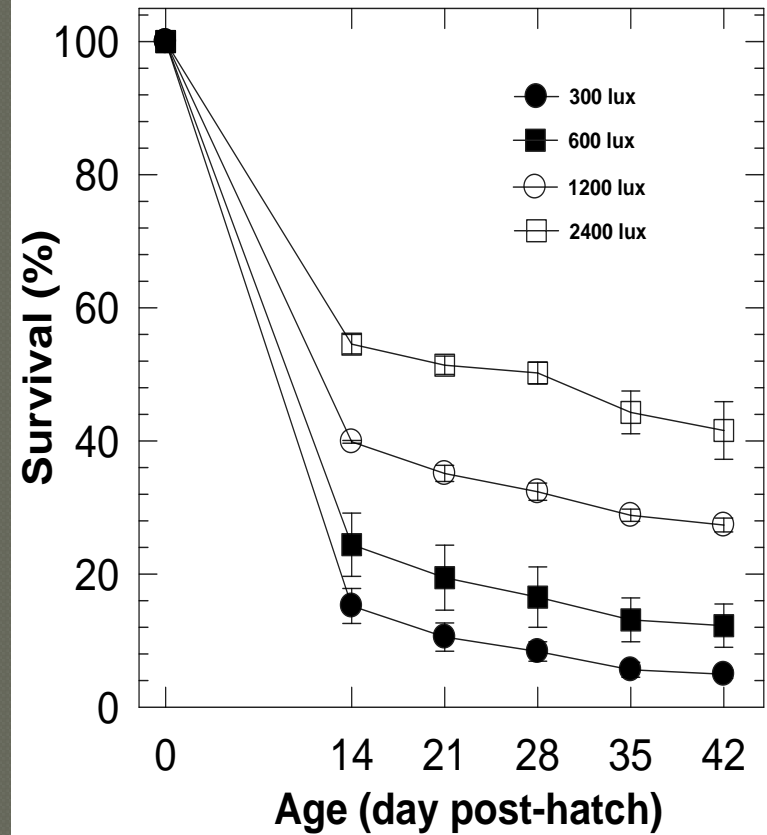
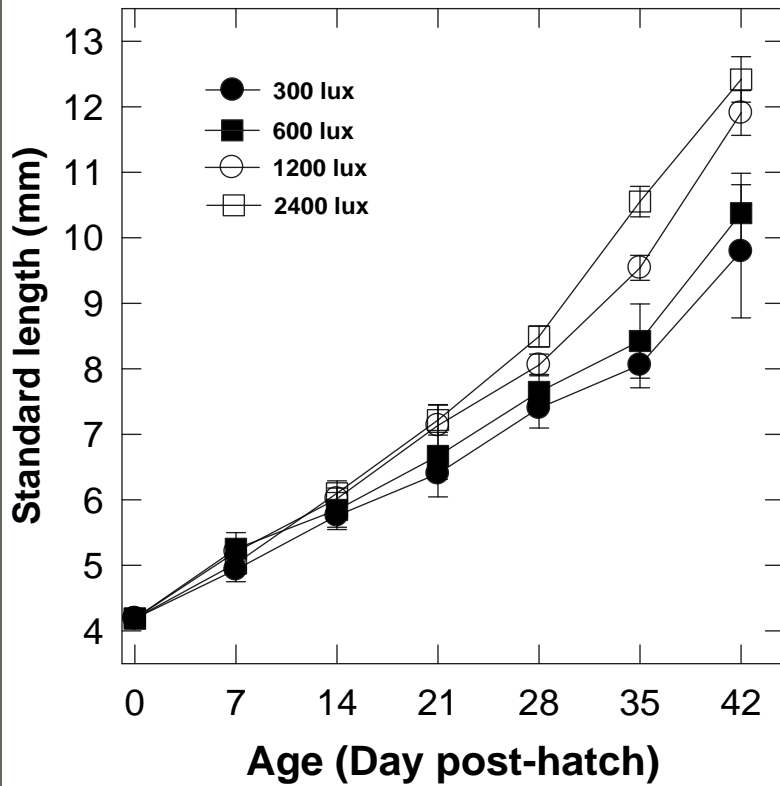
Cod 7dph: Swim bladder inflated.
Feeding on Rotifers.



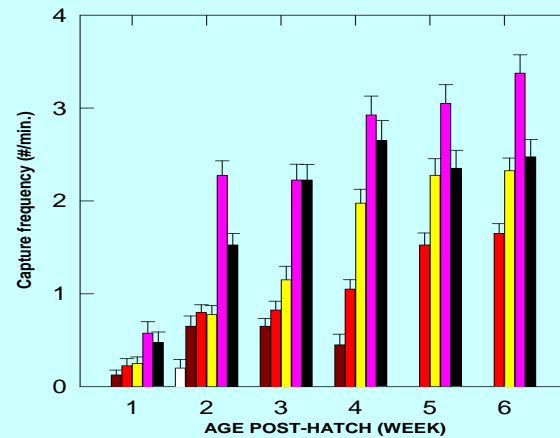
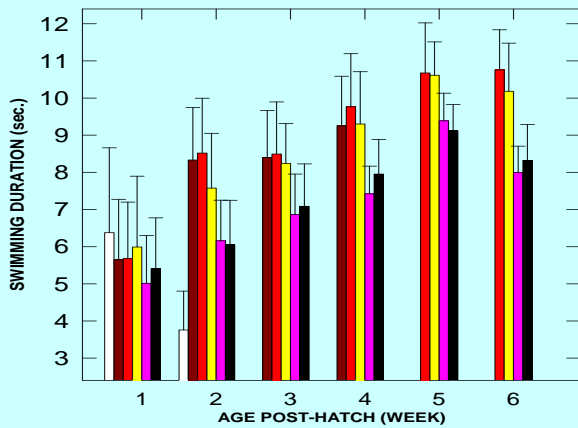
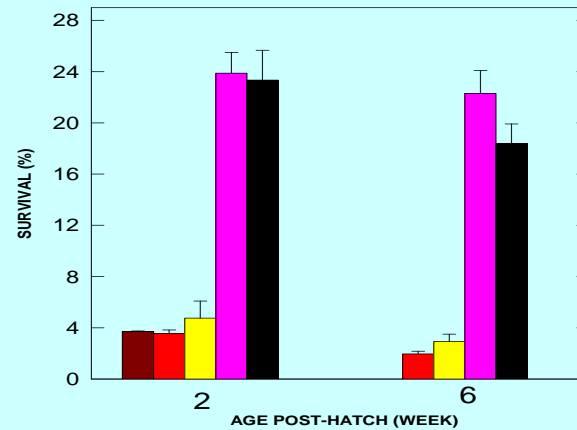
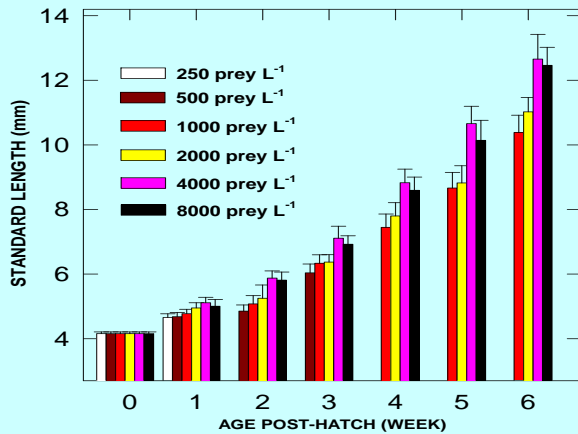
Cod: 21dph.
Initiating tail fin development.



Light Intensity effects



Prey Density Effects



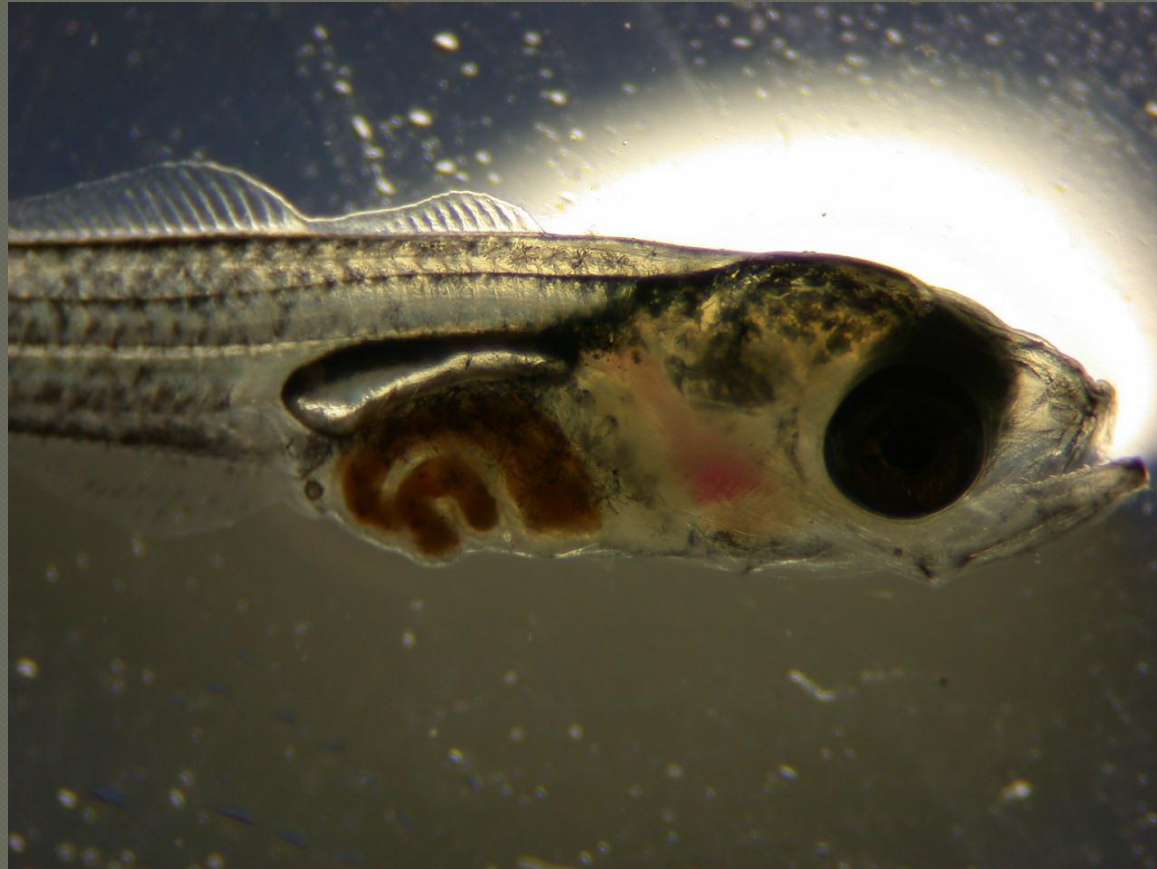
Transition to Artemia:

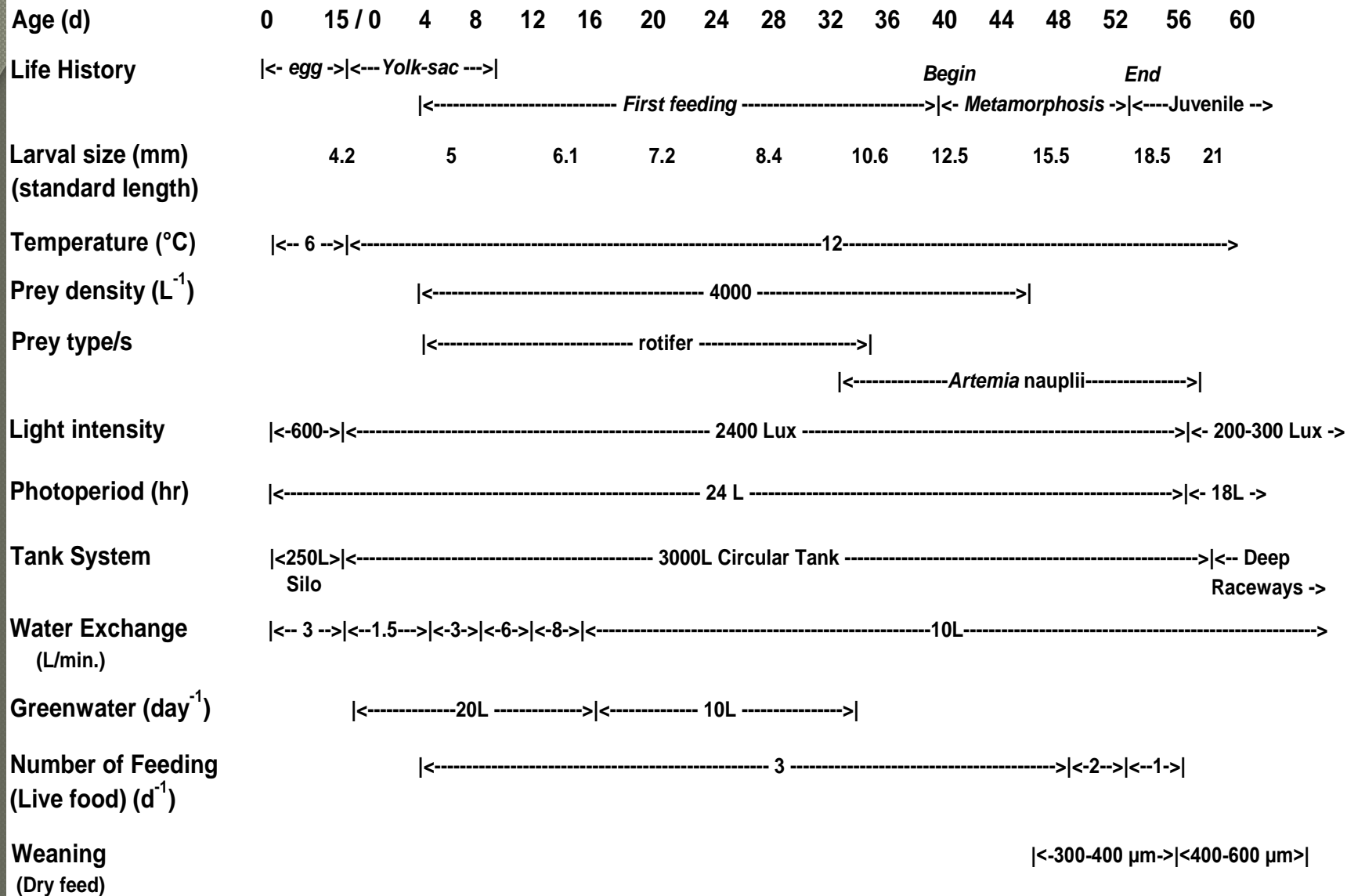
- A change in the composition/and size of the diet
- A change in the bacterial population associated to the diet.

Therefore:

- Start with low Artemia doses.
- Start with newly hatched Artemia
- Move gradually to enriched Artemia
- Keep Rotifer feeds in parallel.

Cod: 33 dph,
Ready for Weaning





Atlantic cod early rearing protocol

Rearing Protocol for Cod

EGGS

disinfection ozone @0.5-1.5mg/l for 30-90s
incubation 10 days @7C

LARVAE

density 20-30/liter
greenwater 10 days
rotifers 25 days (to 12mm); Fed at hours 1300, 2100, 0500
Artemia from day 25-55 (12-20mm); Fed at hours 0900, 1500, 2100, 0300
co-feed from day 25-35 (12-14mm); Fed at 0800, 1400, 2000, 0200
weaning from day 35-55 (14-20mm): per GBA standard weaning program.

WATER FLOW (TANK EXCHANGE RATE)

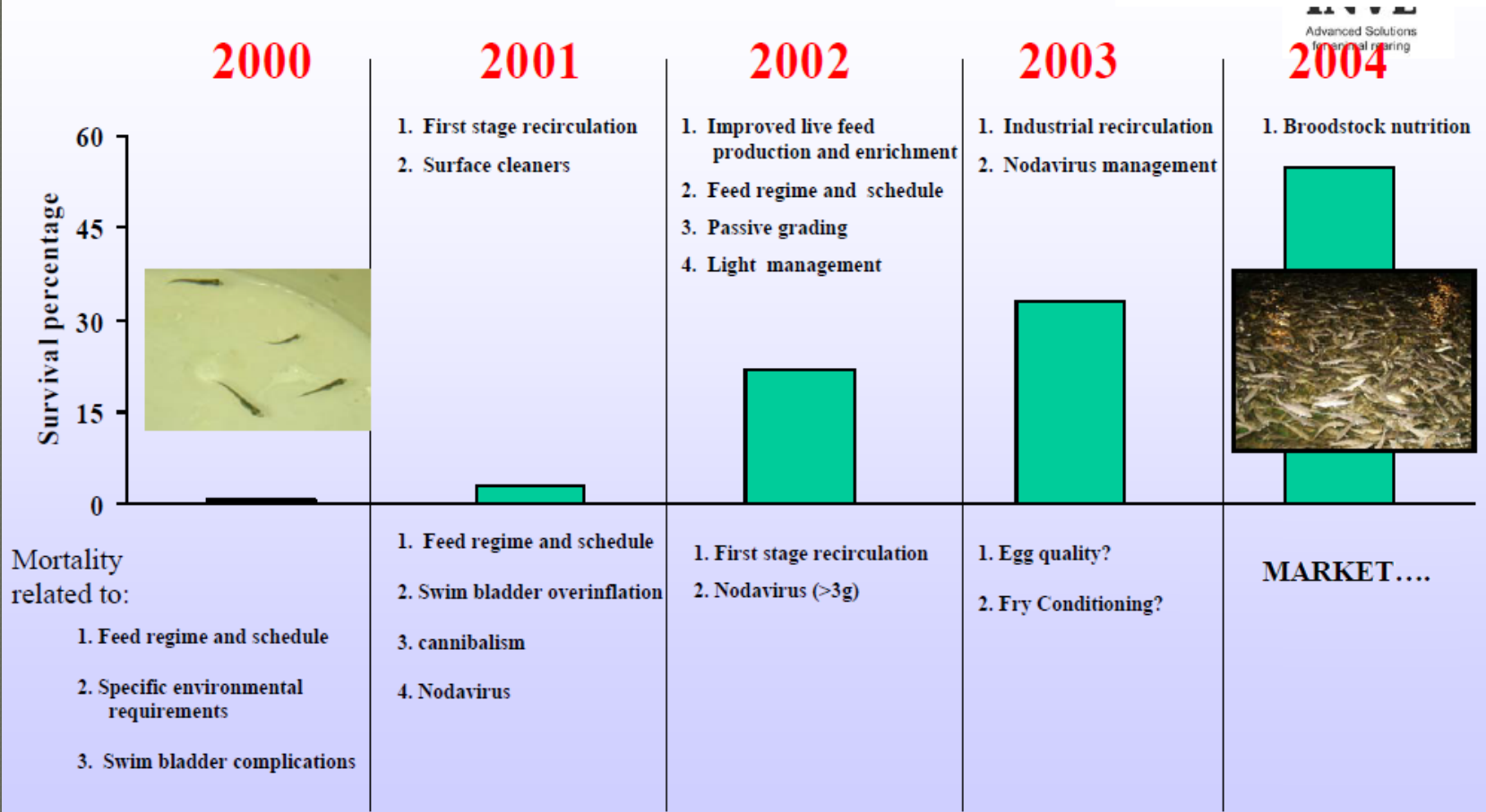
greenwater 1 turn per day
Artemia 1 turn per 5 hours
weaning 1 turn per 3 hours
post-weaning 1 turn per 1.5 hours

TEMPERATURE/SALINITY

incubation 6-9C/35ppt
0-60 dph 10C/30-34ppt
60-100dph 11C/20-30ppt

Torsk en ekte Globetrotter (Kabeljauw een echte globetrotter)
Bergen, Norway 9-11 February 2005

Hatchery Production of Cod: stumbles and strides



Torsk en ekte Globetrotter (Kabeljauw een echte globetrotter)
Bergen, Norway 9-11 February 2005

Cod: Juvenile production status, Norway 2007

- 15 intensive hatcheries
- Total production: 12 mill
- Better quality
- More culling → less deformities
- Juvenile prices 2 – 5 g: 5 – 7 kr
- Capacity: 100 – 130 mil ?



Grethe Adoff

Cod Juvenile production, Norway

	<u>2001</u>	<u>2002</u>	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>
Number of sites	8	17	17	17	13	15
Production (mill.)	1	2	3	5	9	11
Prod. pr site (mill)	0,13	0,12	0,17	0,29	0,69	0,73

Grethe Adoff

Problems

- ⦿ Bacterial issues during Larval rearing.
- ⦿ Deformities.
- ⦿ Low Growth Performance on the Farm.

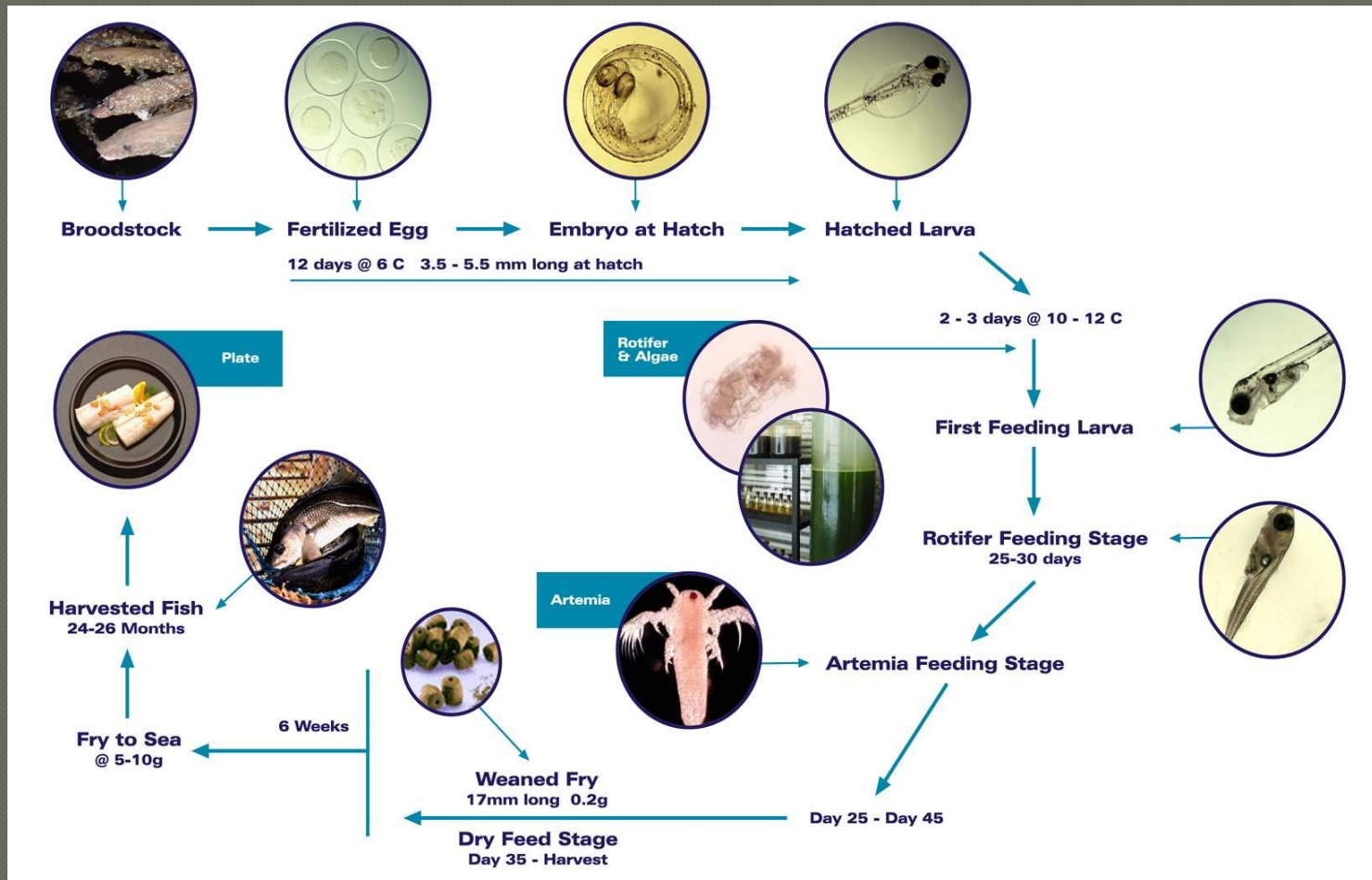
Cod Farm Production

- Size at entry 5g. (May) to 25 g. (Oct)
- October entry 450 g one year later
- Market size @ 4 kg approx 36 months
- Market size from 5 g. fish approx 2.5 kg in 36 months (2004 YC)

Jonathan Moir

Cod Life Cycle - The Know-How

Egg to Plate 30 - 34 months.



Merluza Austral

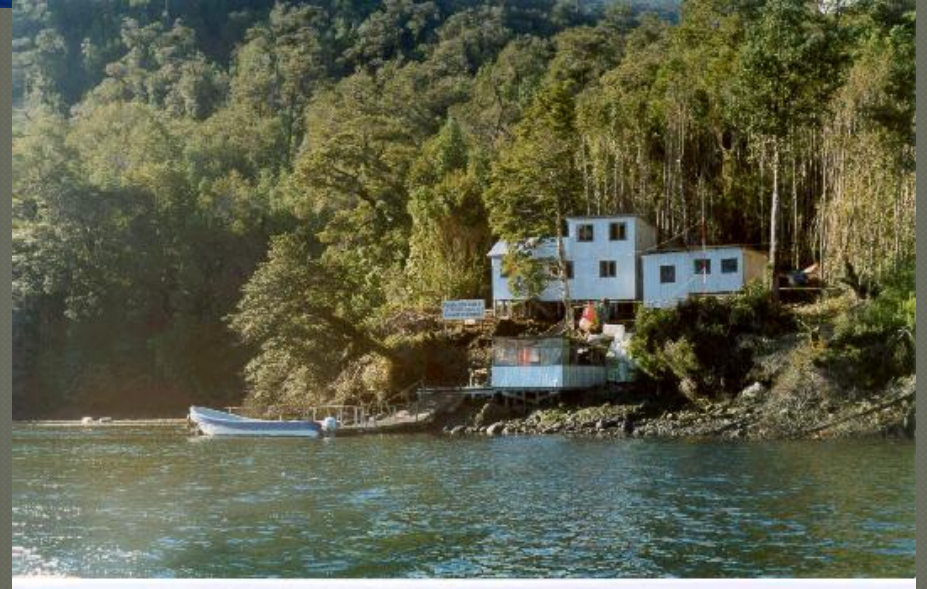


Merluza austral



Broodstock: Cage facility, Isla Chaculay.

From '98-'05



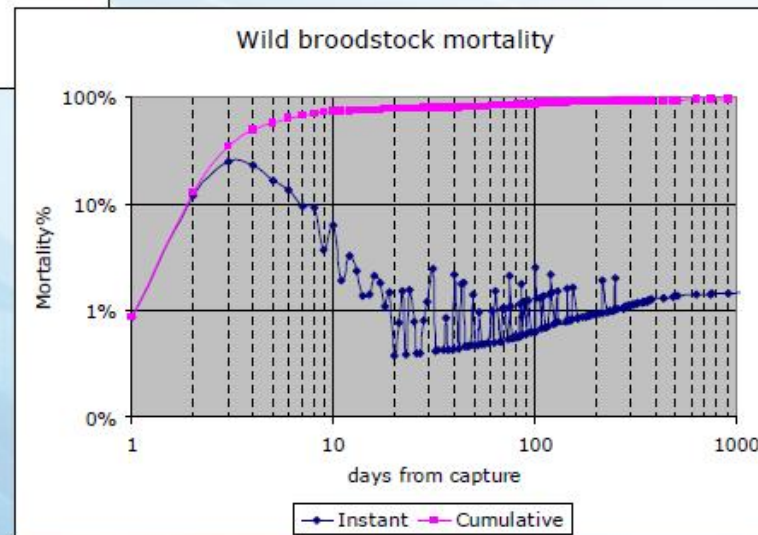
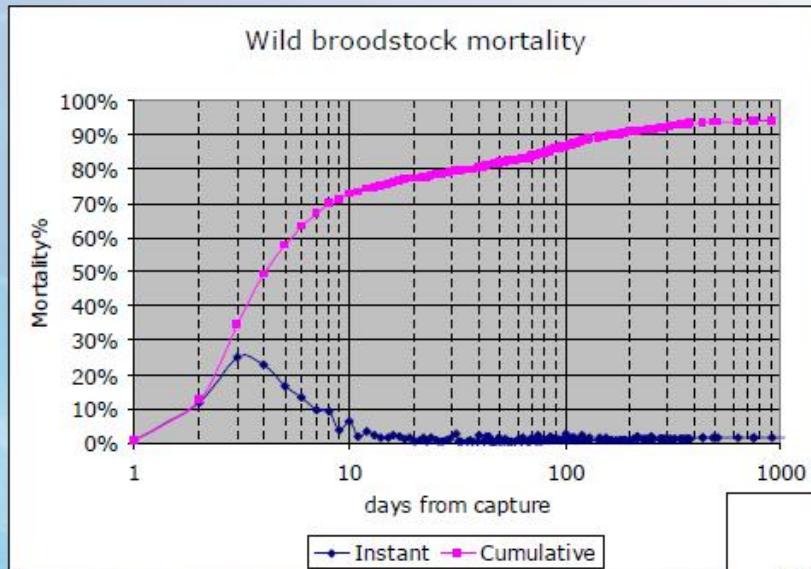
Broodstock : Land Based Facility, Quillaipe.



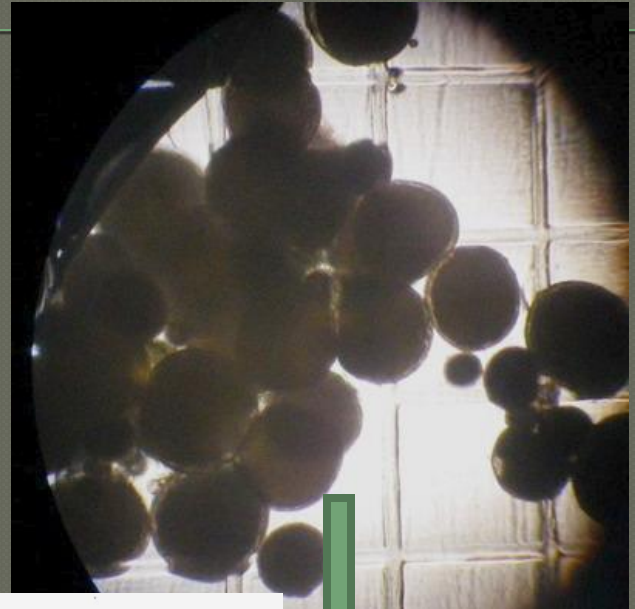
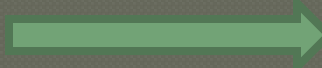
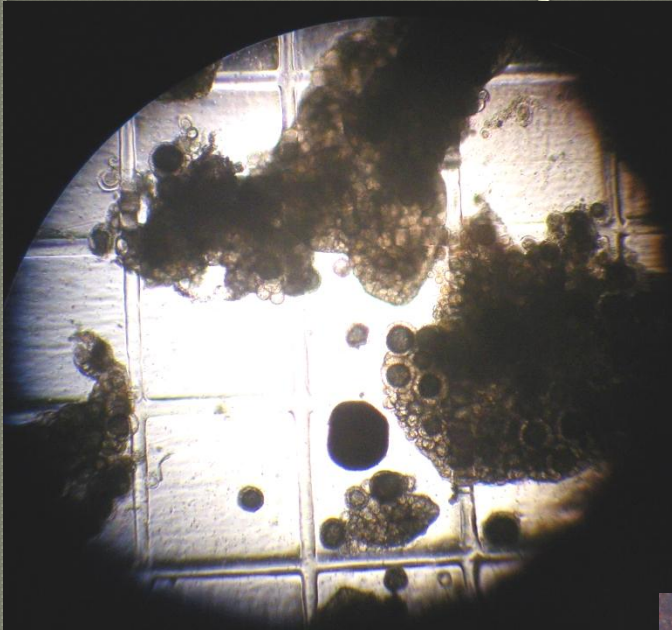
Chaculay to Quillaipе fish transport

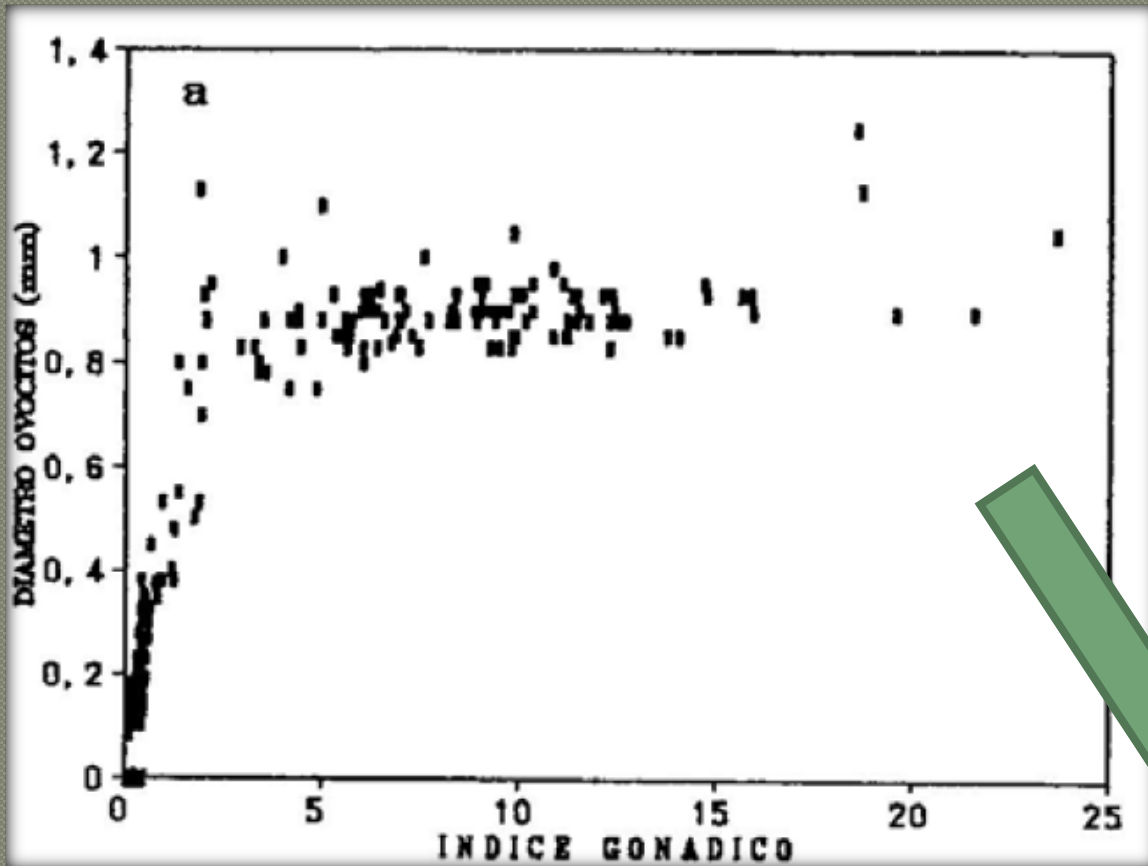


Sobrevivencia Post-captura



Biopsy images from Hake





Balbontin and Bravo 1993

GnRH: 50ug/kg

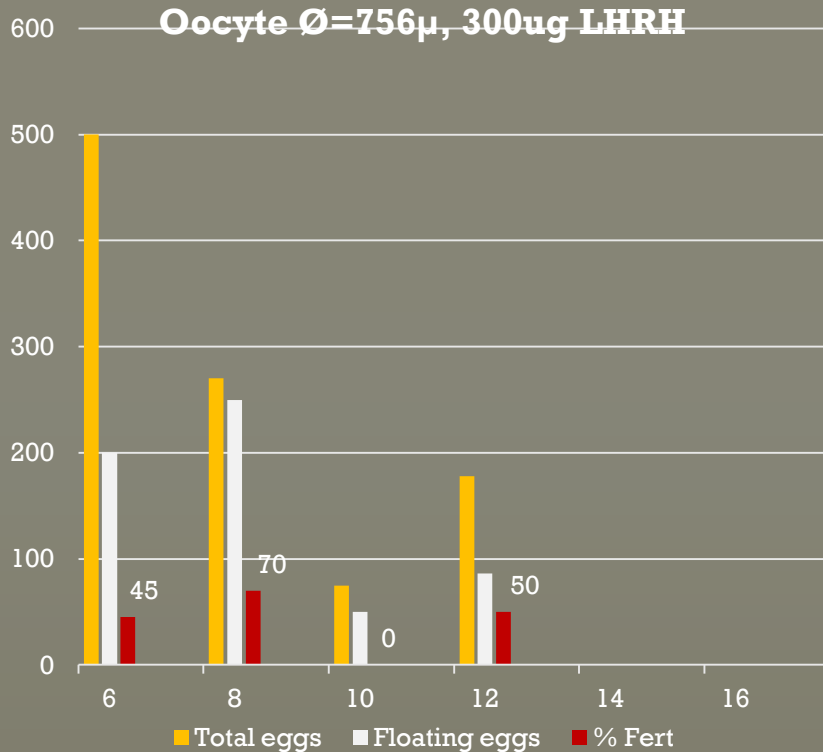
Induce FOM

Hake: Manual stripping



Hake: Induced Spawning

Merluza 1D66, spawning August 2013

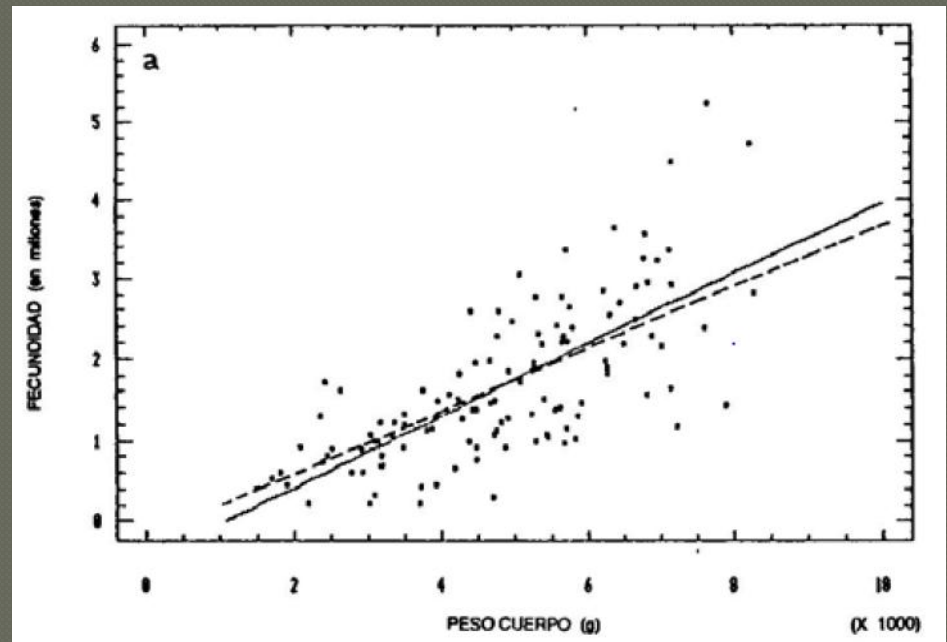


Merluza 2A88, Spawning Aug '13, Oocyte Ø655µ, One spawn 14 dyas post implant of 2x150ug LHRH

Egg Stripped (ml)	200
Floating eggs (ml)	220
Sinking eggs (ml)	10
Percent Fertilization	50%
Incubator	14

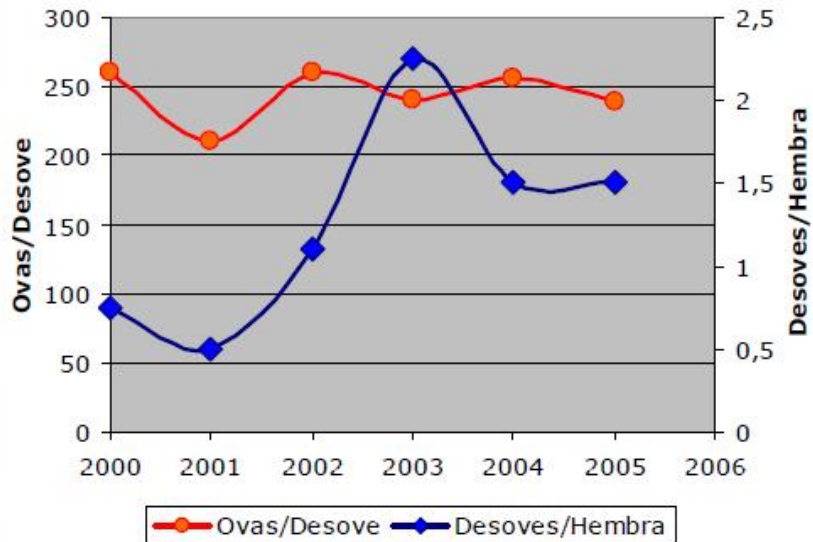
Spawning Characteristics:

- 540,000 eggs/liter
- Hydrated egg diameter: 1.2mm
- A 3Kg female should give about 1 million eggs.
- Male sperm plentiful
- Spawning June-Sept.

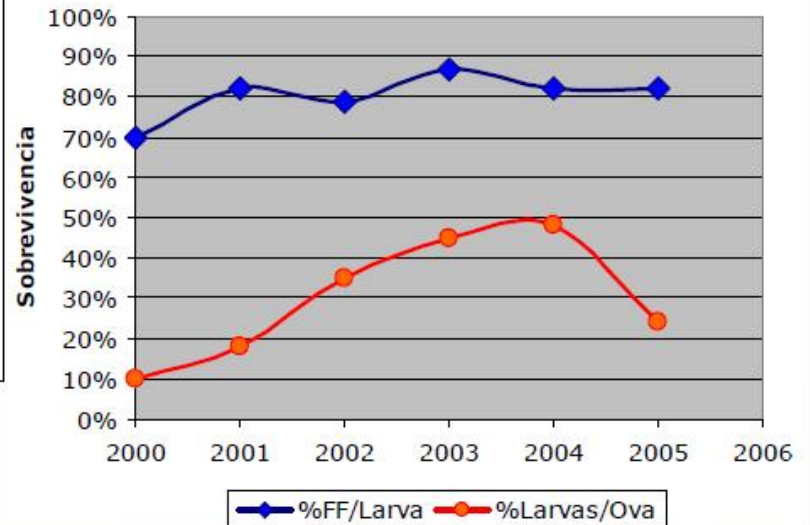


Balbontin & Bravo, 1993

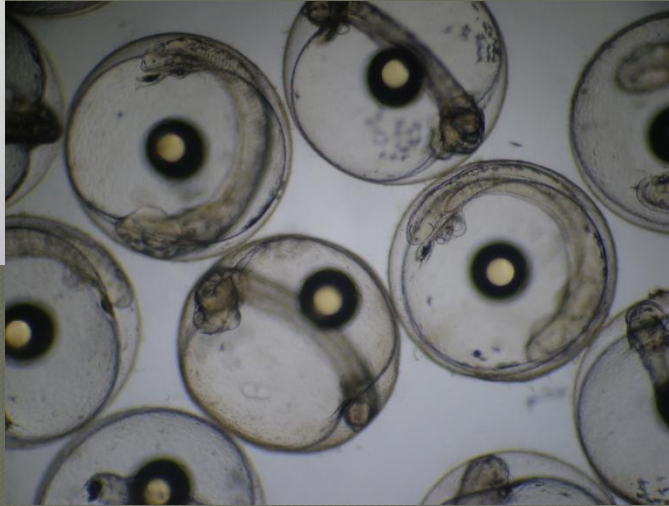
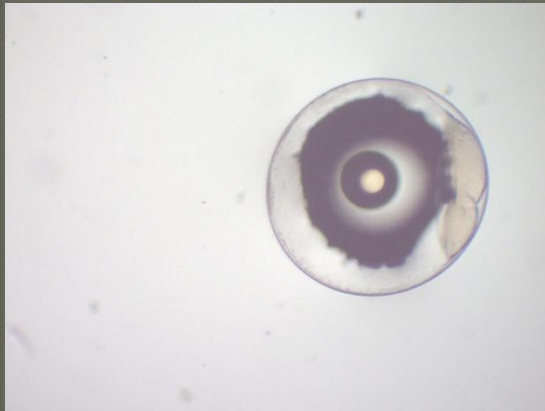
FECUNDIDAD



Rendimiento Incubación



Incubation



6 days to hatch at 11°C

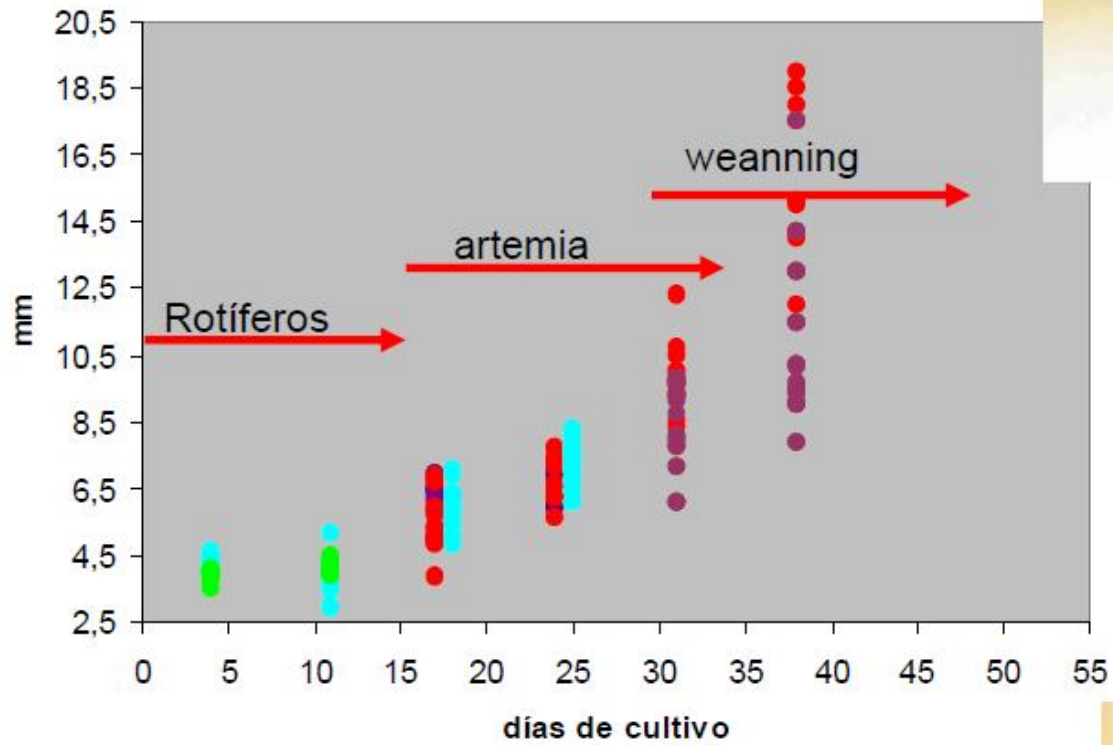


Yolk Sac Incubation

- Yolk Sac larvae of Hake tend to sink.
- Requires upwelling conical tanks.
- Duration: Complete yolk absorption 9-10 days post hatch.



Crecimiento en long. larvas YC05S



Hake juvenile at 70 dph.



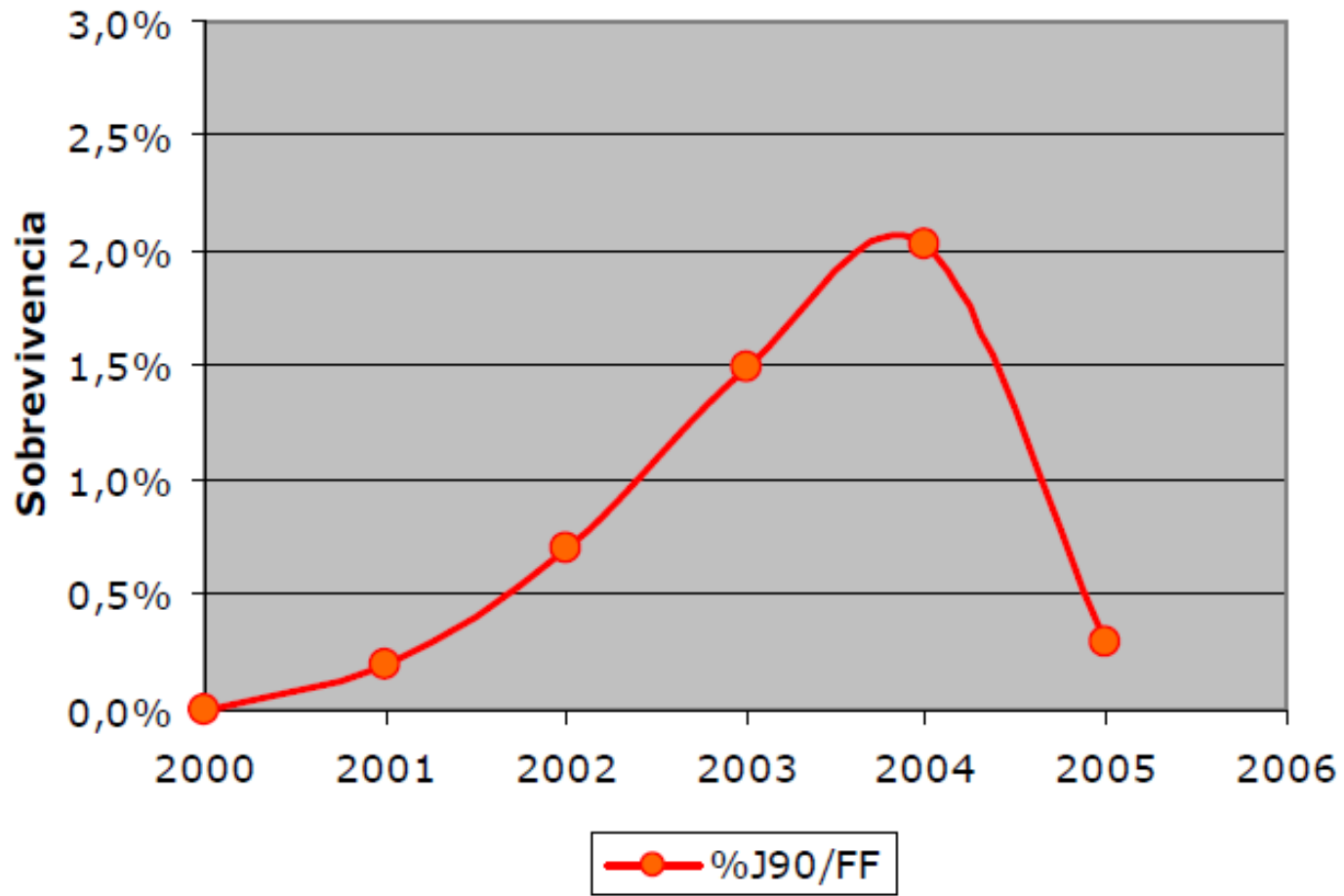


Hake Juveniles

Rodrigo Lewis (2003).
FDC.



Rendimiento Cultivo Larval

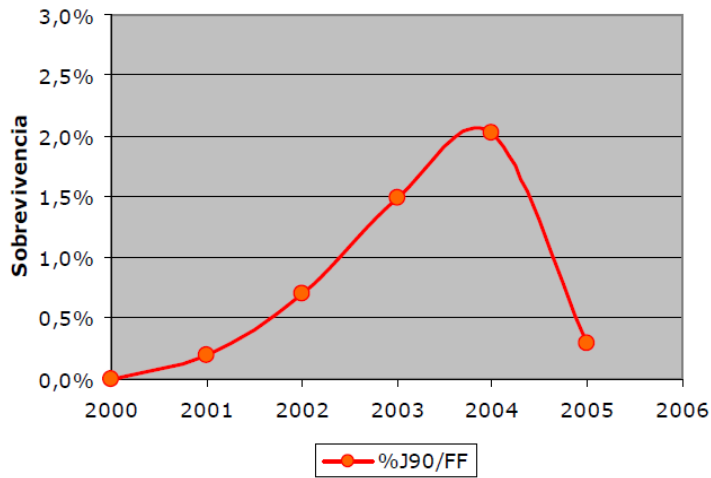


Southern Hake: Problems

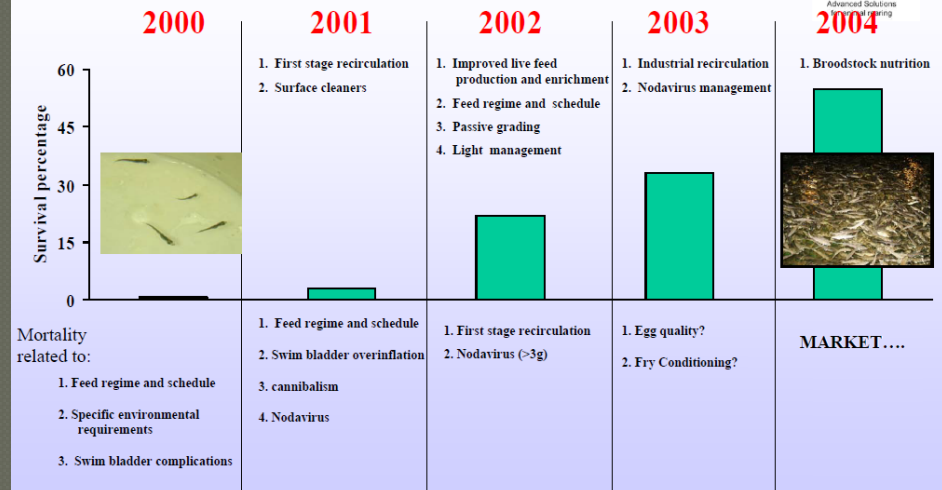
- Broodstock: Low post-capture survival, Induced spawning; Low egg yield, Variable and unpredictable egg quality.
- Incubation: Requires up-welling incubators.
- Larva rearing: Highly susceptible to Bacterial infections.
- Juvenile: Very Cannibalistic.

Hake Vs. Cod

Rendimiento Cultivo Larval



Hatchery Production of Cod: stumbles and strides



Torsk en ekte Globetrotter (Kabeljauw een echte globetrotter)
Bergen, Norway 9-11 February 2005

But: Market for Hake is much better!

Hake Projects:

Fundacion Chile '99-07; '11-13; Alberto Reyes,
Rodrigo Lewis, Gustavo Parada; Carlos Lonza.

Cod Projects:

Sea Forest Plantation, '96-99; The Joe Brown
Laboratory, Nfld.; Profunda AS, Norway.
Aquagem Nfld. (Jonathan Moir).

Teleostei Hatchery Consulting Ltd. Canada,
Gidon Minkoff