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RIM Aqua-Consulting

TRENDS FOR ATLANTIC SALMON PRODUCTION IN LAND BASE SYSTEMS IN CHILE

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UNIVERSIDAD CATÓLICA DEL NORTE

FACULTAD DE CIENCIAS DEL MAR

DEPARTAMENTO DE ACUICULTURA

Aquaculture Innovation Workshop #5

West Virginia, USA

September 4 – 6, 2013

AGENDA

- RAS know-how
- RAS Technology developments
- Present and future R&D

Companies introducing RAS technology

- Billund Aquaculture Chile S.A. (Denmark)
- Hesy Aquaculture (Netherlands)
- INACUI S.A. (Chile)
- PRAqua (Canada)
- Aquatec Solutions (Denmark)
- OCEA (ex-Hydrogest) (Norway)
- AKVA Group
- Atlantech Companies (Canada)

Fingerlings

Smolt

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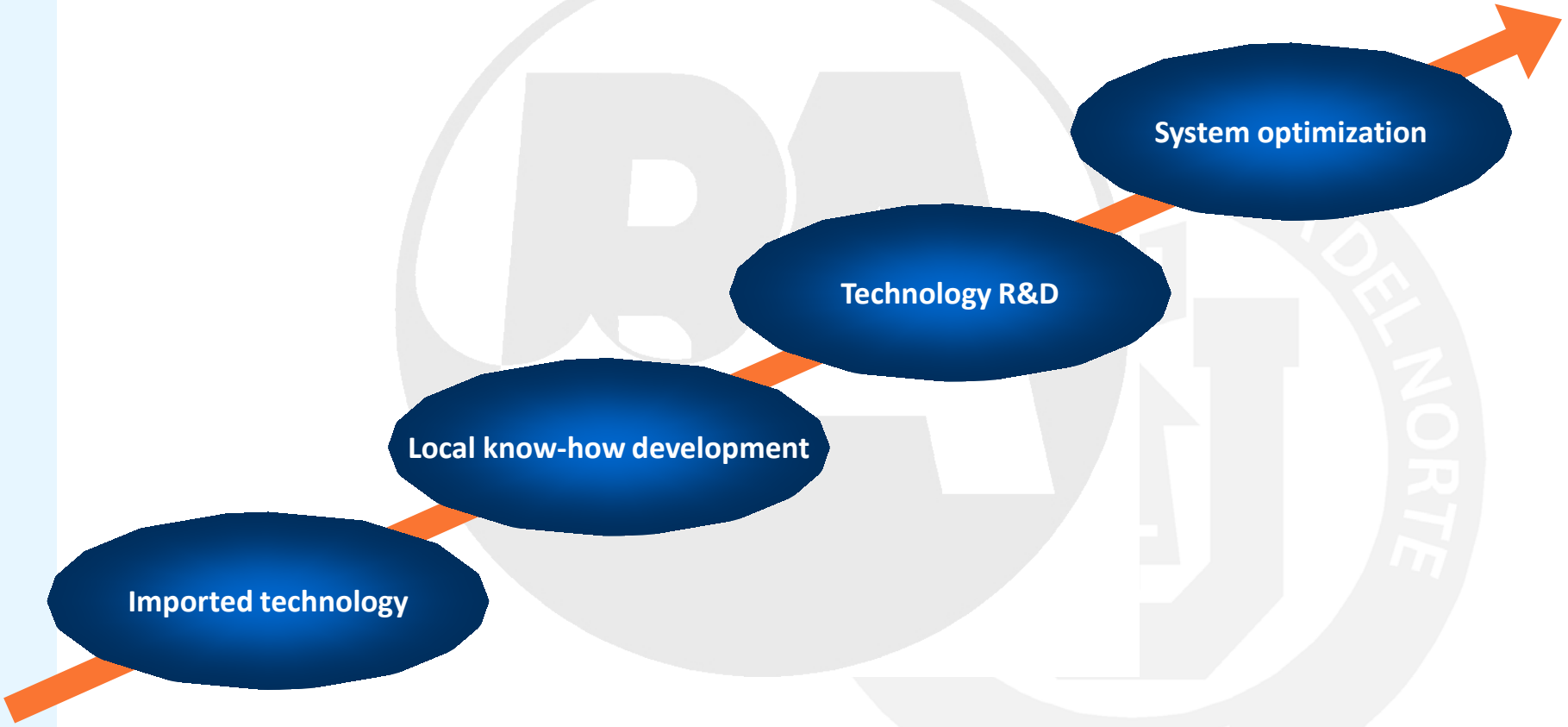
RAS TECHNOLOGY DEVELOPMENT

RAS technology evolution in Chile
Atlantic salmon smolt production



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RAS technology evolution in Chile
Atlantic salmon smolt production

Focus in electrical consumption

$$W = \frac{Q * Hm * \gamma}{\eta} = \frac{P * Q}{\eta}$$

5
KW/Kg feed

2 – 2,5
KW/Kg feed

Where:

W: Consumption (W/h)

Q: Flow (m^3/s)

Hm: Manometric Height (m).

γ: Specific weight of water column (9810 N/m^3)

P: Discharge Pressure

η: Eficiency Equipment

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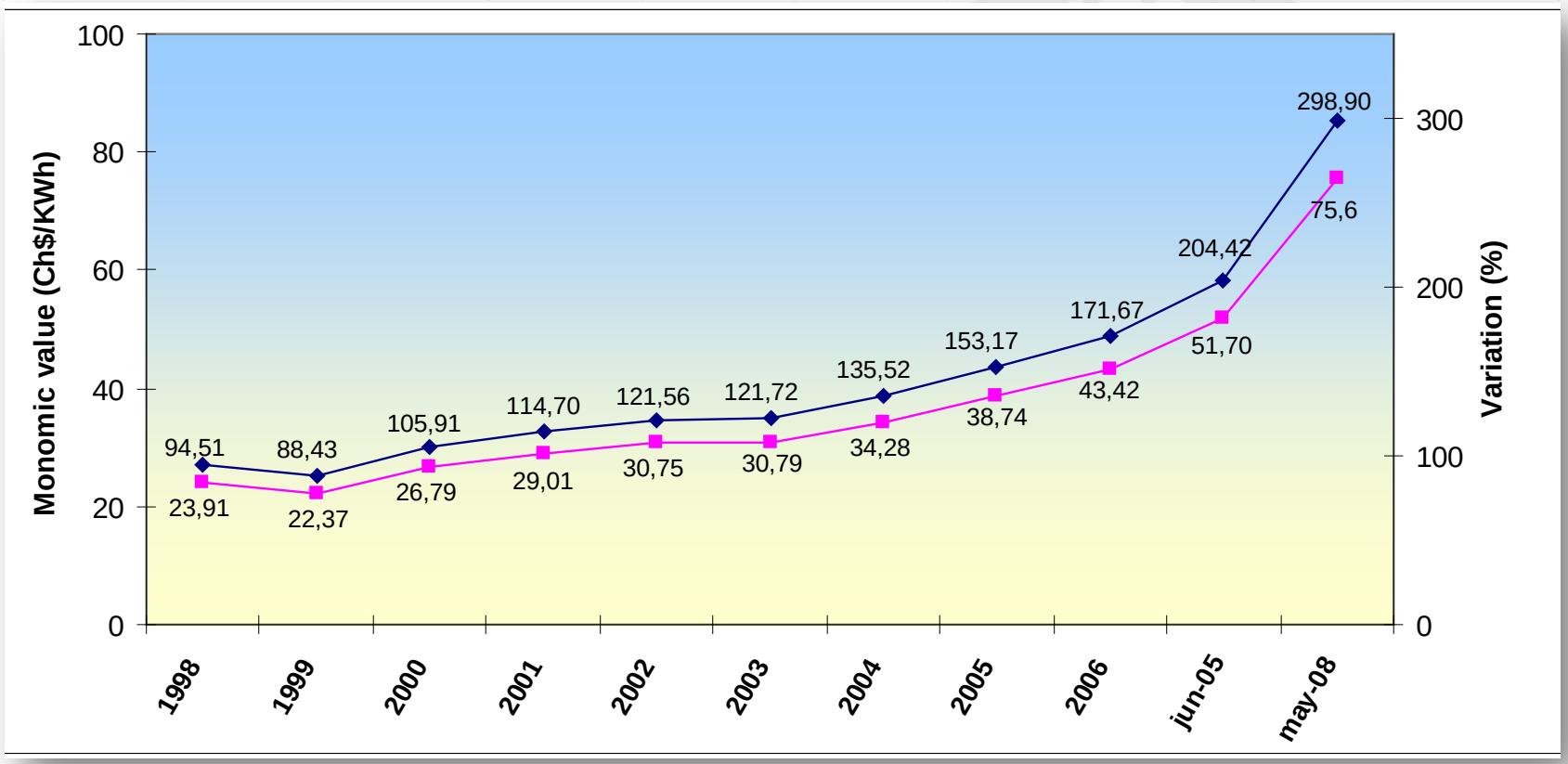
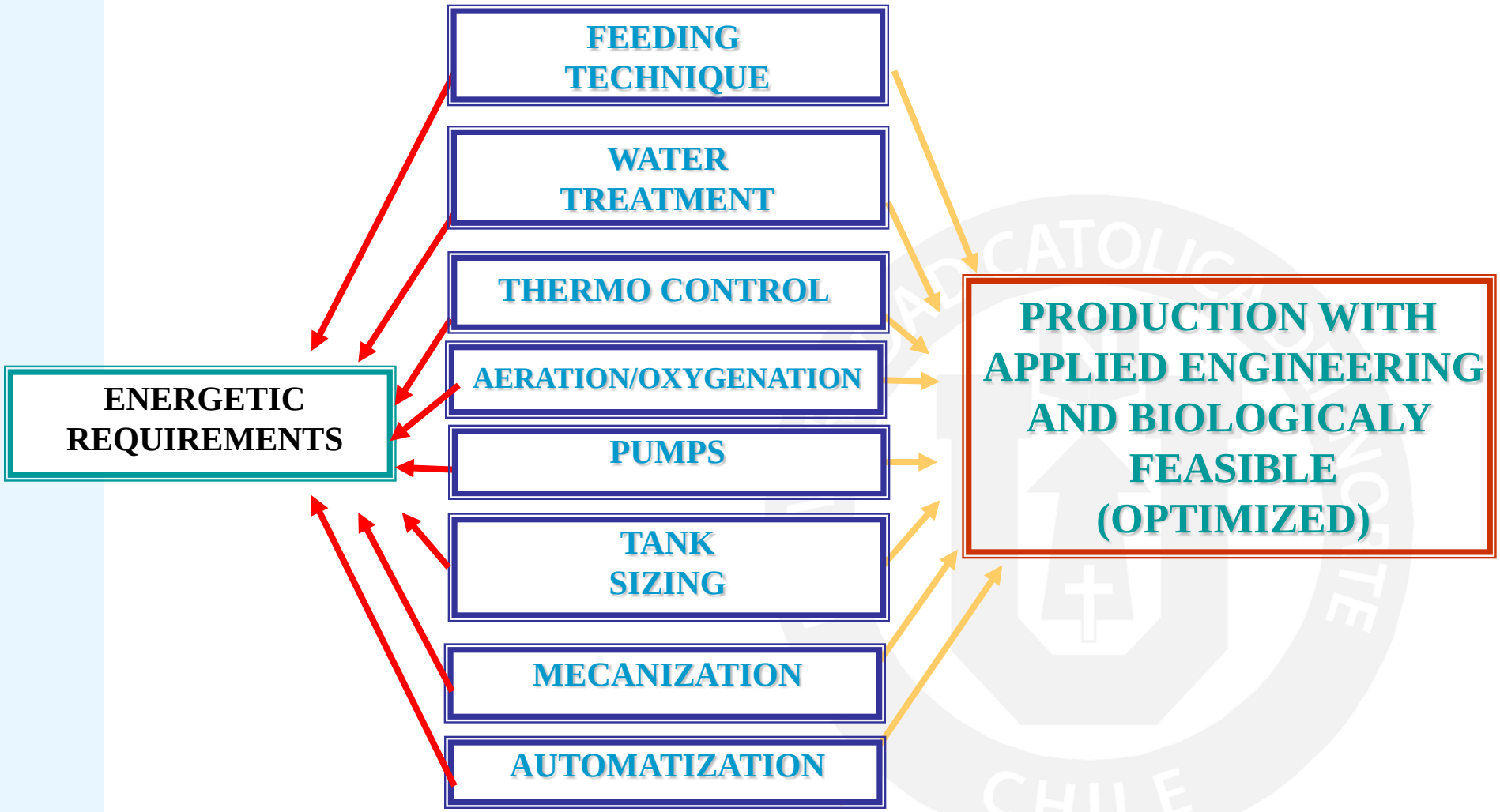
Problem

- ✓ Continuous rising on the energetic costs (104% last decade)
- ✓ Variable environmental conditions during seasons and even days





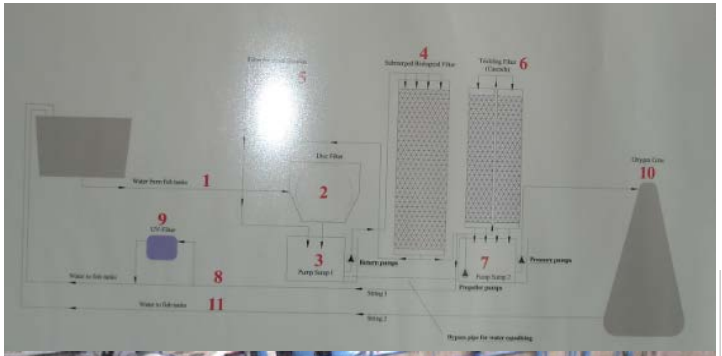
Varies according to rearing technique
Varies according to water flow regimen

RAS HYDRAULIC GENERATIONS

✓ FIRST: Two centrifugal pumps stations and piping

✓SECOND: One centrifugal pump station and piping

✓THIRD: One Helix pumps station and channels



Biological media and biofilter types trends

Submerged bioblock
Other fix media
Fluidized beds

Fingerlings

Smolts

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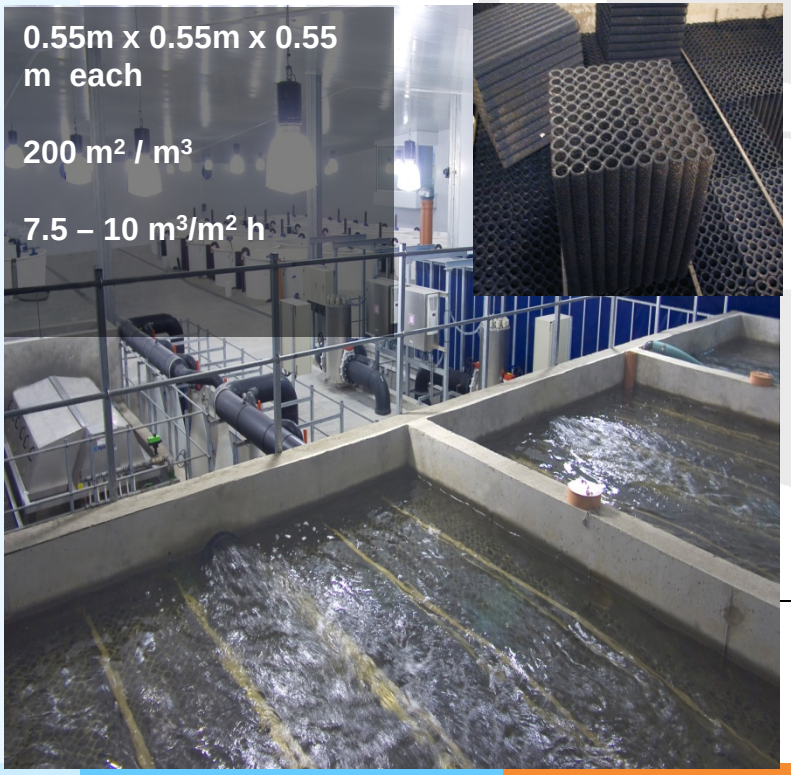
Biofiltration systems

Static biofilter

Fluidized biofilter

Bio-Bloks

150-200 m^2/m^3



Bio-Cells

650 m^2/m^3

Sand

12,000 m^2/m^3

Double drain rearing tanks

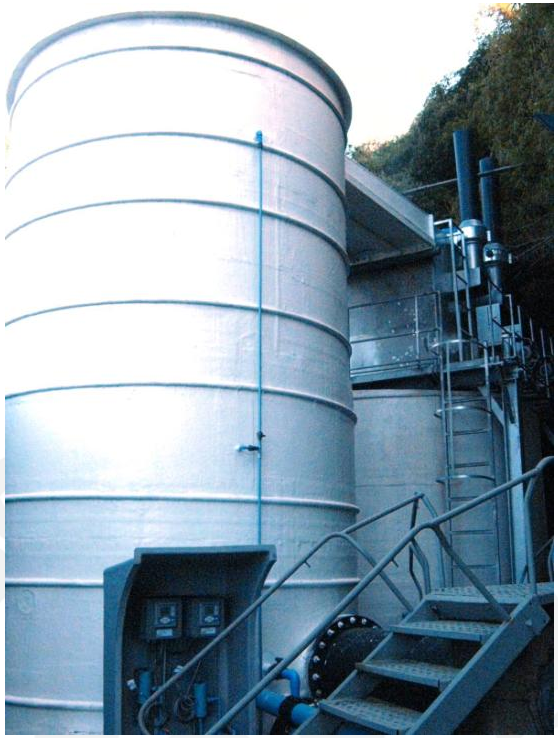
Double drain tank with internal mortality device removal

Tanks from 500 m³

Radial settler

OZONE CONTACT TANK

- Diameter: 3.5m
- Height: 6.0m
- Volume: 58m^3
- Material: FPR ozone resistant
- Contact time: 4.17min at 834 m^3/hr
- Upward flow velocity: 0.024 m/s

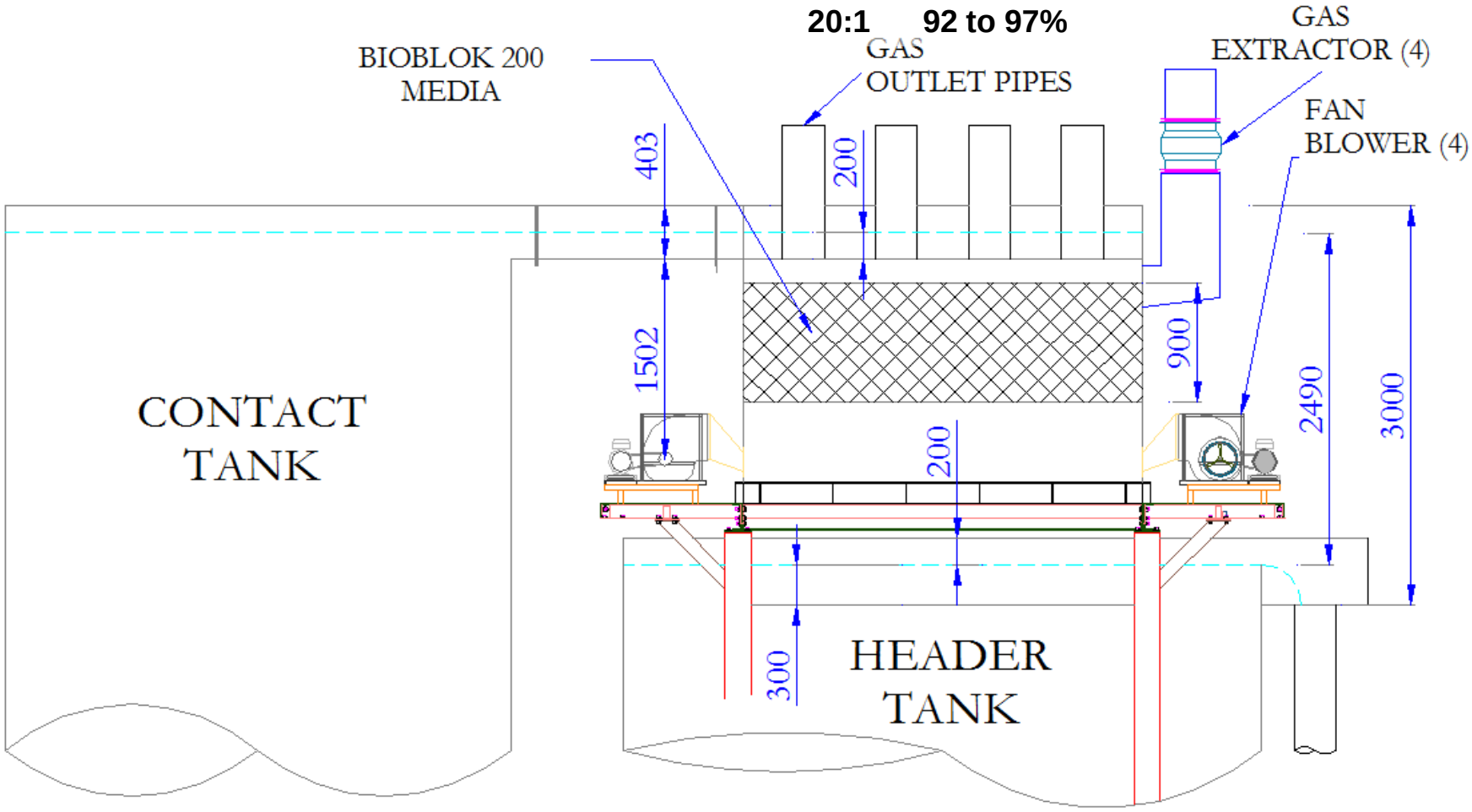


Contact tank 6.0m

Contact tank outlet tray

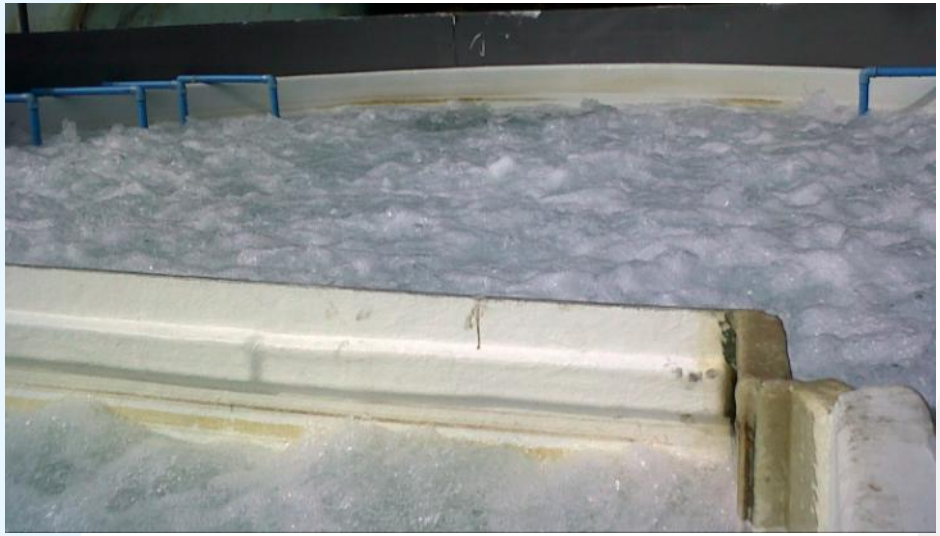
OZONE AND UV SUPPLY WATER DISINFECTATION

G:L	Removal
0:1	67 to 73%
12:1	81 to 87%
20:1	92 to 97%

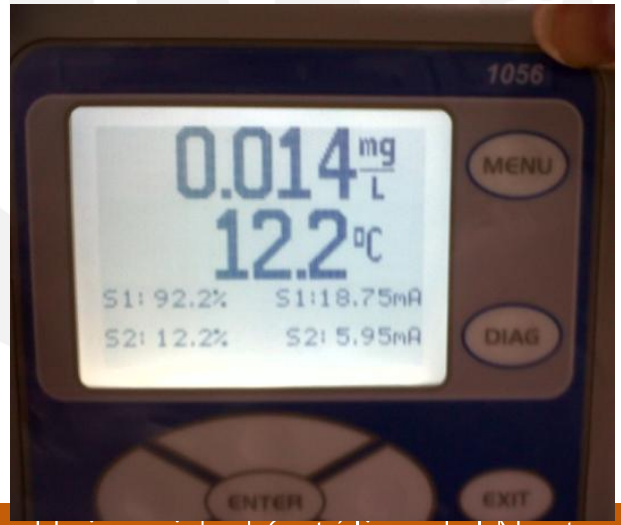


Contact tank and degassing tower elevations (dimensions in millimeters)

OZONE AND UV SUPPLY WATER DISINFECTATION

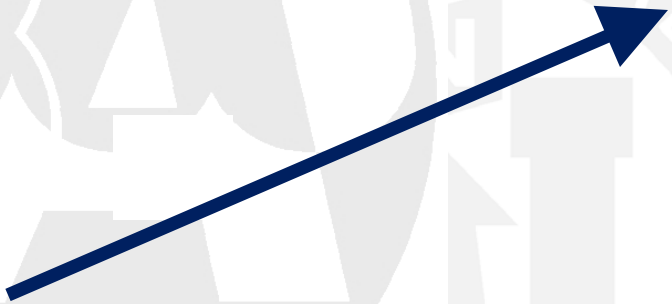


Eff.
98.4%



RAS technology evolution in Chile
Atlantic salmon smolt production

Tank water exchange increment



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Atlantic salmon fingerlings at 40 g and target to 200 g

Salinity between 5 to 11 ppt depending on fish weight and smoltification strategy.

10 rearing tanks with 15 m diameter, 3 m depth and 500 m^3 each.

8 submerged biofilters and 1 fluidized biofilter.

Water flow 8.000 m^3/h.

2 UV filter with an intensity of 200 (mW/cm^2/s) each.

2 seawater uptake pumps with 150 m^3/h each, ~ 6% VS/day

- **sand filters,**
- **Ozone at 0,2 mg/L, or 30g de Ozone/h**
- **UV.**

1. **Affluent**

RAS versus flow through smolt production per year

Ítem	RAS	Flow through
N° smolts	14.000.000	14.000.000
N° eggs	20.000.000	28.000.000
m^3 for smoltification tanks	10.000	20.000
Batch	4	2
N° smolts /m^3 tanks	1.400	700
m^3/ day wastewater	5184	480.000
Labor	55	120

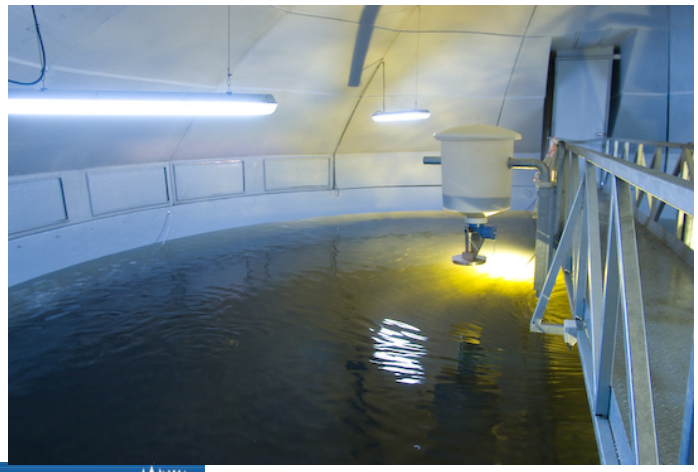
Rearing technology	TAN (mg/L)
open flow	1.22
water reuse	1.61
RAS	4.8 @ pH 7.1

Production costs between RAS and Flow through

Production cost USD/unit	RAS	Flow through
Egg Cost	0,21	0,30
Feed Cost	0,17	0,18
Production Cost	0,60	0,59
Smolt Cost	0,98	1,07
Vaccine Cost	0,28	0,28
Total Smolt Cost @ facility	**1,26**	**1,35**

Using public power - 0,11

Smolt Cost **1,15**



Taken by Esteban Emparanza

Atlantic salmon smolt
Production capacity in Chile

Recirculation	**45.700.000**	**45%**
Flow through	**55.300.000**	**55%**
Annual Total	**101.000.000**	**100%**

Atlantic salmon production in RAS in Chile

Year	Company	Project	Smolt 80 g	Smolt 100 g	Percentage
2000-2008	**Camanchaca**	**Petrohué**	**18.000.000**	**14.400.000**	**39%**
2006	M.Harvest	Rauco	7.500.000	6.000.000	16%
2007	Humboldt	Santa Juana	7.000.000	5.600.000	15%
2008	Sealand	Pargua	6.000.000	4.800.000	13%
2008	Invertec	Lago Verde	4.000.000	3.200.000	9%
2008	Novofish	Pargua	3.200.000	2.560.000	7%
			45.700.000	**36.560.000**	

Gentileza: Juan Pablo Andaur - Camanchaca

Gentileza: Juan Pablo Andaur - Camanchaca

PRESENT AND FUTURE R&D

- RAS systems are an opportunity because of:
  - Chilean aquaculture law has high quality standards for wastewater discharges
  - Higher growth rates in comparison to flow through
  - Water conservation and reduction of water print
  - Biosecurity standards for broodstock:
    - have to be reared away from ocean
    - Broodstock selected and reared from egg stage
- RAS Commercial Atlantic salmon experiences have been successful

General description of the Chilean salmon

Indicator	2007	2008	2009	2010e
Sales FOB (MM USD)	2,246	2,137	1,360	1,130
Total Harvests (tons)	658,260	663,000	422,000	352,000
Atlantic Salmon	355,430	388,000	174,000	87,000
Trout & Coho	302,841	275,000	248,000	284,000
Physical Sales (net tons)	397,041	400,766	255,000	213,000
Number of Companies	27	30	28	25
Est. Ind. Fin. Debt (MM USD)	N/A	2,000	2,300	2,300
Direct and indirect jobs	N/A	55,000	42,000	38,000

Source: Kontali, Sernapesca, Multiexport

CAMANCHACA S.A.

PISCICULTURA RIO PETROHUE

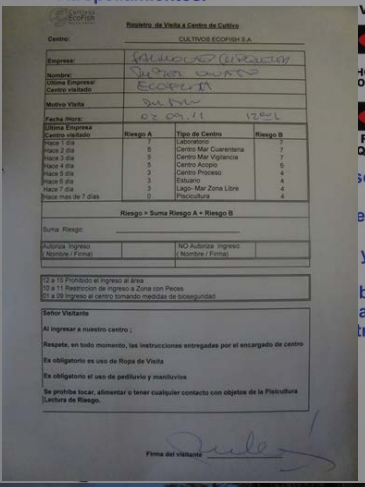
Sr. Visitante, al ingresar a las dependencias Ud., puede estar expuesto a:

- Riesgos eléctricos, media tensión.
- Atropellamientos.

PELIGRO ALTO VOLTAJE

PELIGRO GRUA HORQUILLA OPERANDO

PELIGRO RIESGO QUIMICO



Normas de BIOSEGURIDAD:

- Para ingresar al centro Ud., debe llenar "DECLARACION DE INGRESO", con el objetivo de conocer si ha visitado en las últimas 24 horas alguna zona de alto riesgo (Centros de cultivos, centros de matanza o cosecha, embarcaciones de uso común, embarcaderos y laboratorios de ictiopatalogía).
- Si Ud., visitó alguna zona de alto riesgo no significa que se le negará el acceso.
- Los vehiculos deben estacionarse fuera del recinto.
- Si requiere ingresar materiales debe avisar a administración para coordinar la desinfección de su vehículo.
- Para ingresar utilice el pediluvio y maniluvio.
- Observe el diagrama publicado en el ingreso, donde podrá ubicar las dependencias del centro y las zonas rojas y amarillas.

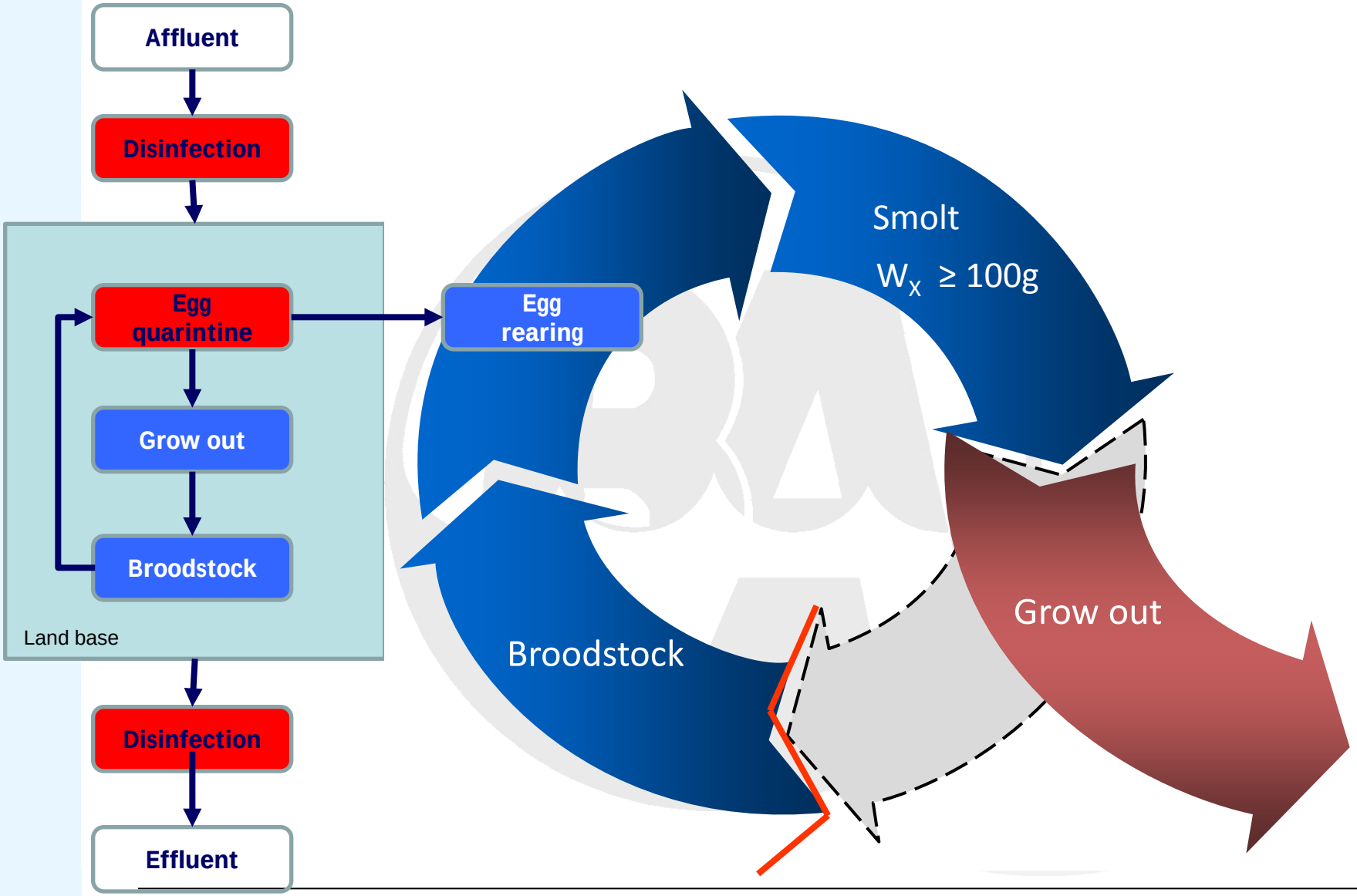
E EXCLUSIVO VISITAS

20 km/h VELOCIDAD MAXIMA

NO FUMAR

SOLO PERSONAL AUTORIZADO

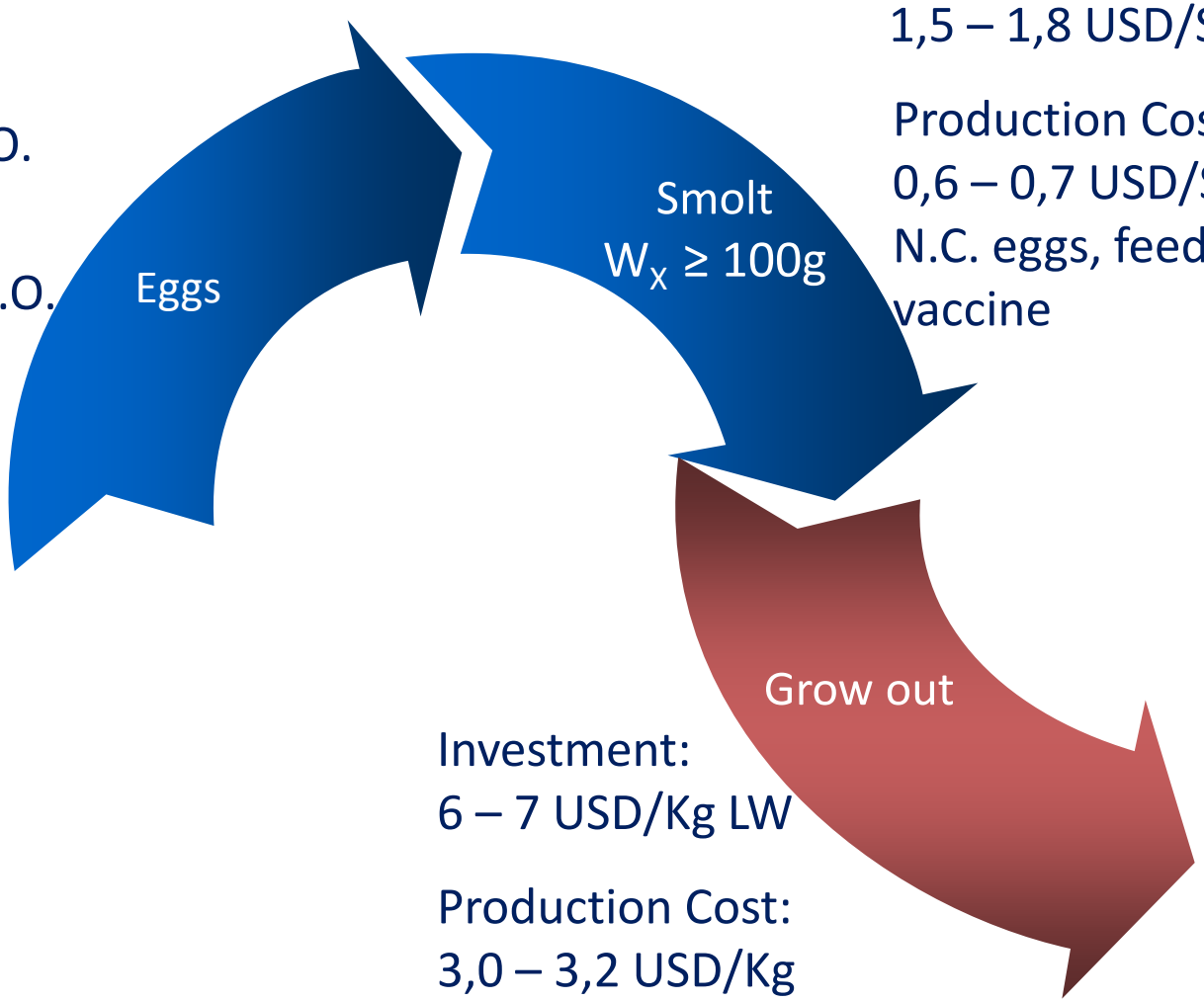
Trends RAS and the new productive model



Trends RAS and the new productive model

Investment:
0,2 – 0,25 USD/O.O.

Production Cost:
0,06 – 0,08 USD/O.O.



Investment:
1,5 – 1,8 USD/Smolt

Production Cost:
0,6 – 0,7 USD/Smolt
N.C. eggs, feed and vaccine

Investment:
6 – 7 USD/Kg LW

Production Cost:
3,0 – 3,2 USD/Kg

O.O. eye egg
N.C. not considering
LW live weight

Bioprogram Rearing in RAS

Hatchery	Fingerling Room	Smoltification Rooms		
Eye egg reception	Fingerling	Smoltification		SEAWATER
Disinfection Incubation Absorption	Sac Fry to 25 g 24 h light 5 months 16.0°C	Winter Photoperiod 10 h light / 14 h dark 6 weeks 14,5°C	Summer Photoperiod 24 h light 4 to 6 weeks 14,5°C	

Vaccination:

5 components: IPN, SRS, Vibrio, Aeromona, ISA

Fish size > 35 gr

Trends for RAS technology

- Minimize operation cost (electricity)
  - Efficient pumps stations
  - Gravity flow (gravitational biofilter flow; channels)
- Maximize diseases control
  - Efficient disinfection affluent/effluent systems (ozone plus UV)
  - Eggs from Broodstocks reared in closed production cycle
- Minimize production costs (smolt transport)
  - Set up RAS near shoreline to discharge smolt straight to wellboats
  - Suspended solids removal through R&D in RAS feeds

Projected upcoming facilities 2010

Proyectos futuros o en construcción según empresa					
Empresa	**Proyecto**	**Ubicación**	**Producto[1]**	**Tecnología[2]**	**Estado de avance[3]**
Los Fiordos			Smolts		Busqueda de terreno
Aquachile	Puelo	Río Grande	Smolts	Recirculación	construcción Julio 2011
Aquachile	Chaicas	Chaicas	Ovas	Recirculación	construcción Abril 2011
Aquainnovo	Lenca	Lenca	Experimental	Recirculación	Construcción
Itata		Huenquillahue			DIA
M. Harvest	Rauco 2	Chiloe	Smolts	Recirculación	Anteproyecto
Ventisqueros		Río Negro			Busqueda de terreno
Novofish	Ampliación	Pargua	Smolts	Recirculación	construcción
Sealand	Ampliación	Chayahué	Smolts	Recirculación	Construcción
Pescachile		Aysen	Smolts	RC flujo abierto	Anteproyecto
Cupquelan		Por definir	Smolts	Recirculación	
Yadran	Las Quemas		Smolts	Flujo abierto	Construcción
Humboldt		Pargua	Pre engorda	Recirculación	Anteproyecto
Acuimag	Natales	Pto. Natales	Smolts	Recirculación	Anteproyecto
Multiexport	Chaparano	Chaparano	Smolts	Reuso	Construcción
M. Harvest	Reproductores	Trainel	Reproductores	Recirculación	Anteproyecto
Invertec	Eco-Smolt II	Lago Verde	Smolts	Recirculación	Anteproyecto
Landcatch	Ampliación	Curacalco	Alevinaje	Recirculación	Anteproyecto
Salmones Dalcahue	San Patricio	San Patricio	Alevinaje	Recirculación	Anteproyecto

19 new projects!!!

Salmon neighborhoods

- Main cages problem is sealice (minor are SRS, ISA and another)

- ISSUE 1.Neighborhoods
  - Fisheries and Aquaculture Law changes in 2010 due to ISA
  - Cages located in a given area are now grouped into neighborhoods
    - Allows coordinate sanitary management among enterprises (ie. disinfection, delousing, sanitary area rest)
    - Sanitary area rest dates established by authority to be 24/3 months
  - Logistic implications for 24 months production and 3 months rest
    - Lower production: with regular smolts harvest takes about 16-18 months; having 8 to 6 months left plus 3 month unable to produce in that area
    - Possible solution: FW-RAS smoltification land based systems able to turn into SW-RAS for fish up to 0.5-1 kg
    - Seeding cages with 0.5-1 kg fish allows two production cycles (12 month or less each) at the cages within a 24 month period

Salmon neighborhoods

- ISSUE 2. Larger smolts are required (before 100g) now> 150g
  - Mortalities increasing when transfer to ocean cages
    - Osmoregulation symptoms problems even though ATPasa tests are ok
    - Vaccination has to be applied to larger fish so to have the minimum +600 UTA post vaccination (best antibodies development)
    - There are glances that a negative effect happens when transferring fish undergoing smoltification.
  - Production protocols changes
    - It was required to modify photoperiods protocols from weeks (10 to 12 wk earlier) to fish weight (50 g) and just then start winter photoperiod (12wk+)
    - Then smoltification is delayed, grow continues and vaccination at 100 g
    - Summer photoperiod start 4 to 6 wk before fish release to cages
    - Mortalities were reduced up to near zero.

Salmon towars SW-RAS

- FW-RAS able to turn into SW-RAS for rearing fish up to 0.5-1 kg
  - Seeding cages with 0.5-1 kg fish
- Already exist SW-RAS at north Chile!
  - Yellowtail kingfish (Seriola lalandi)
  - Palm fish (Seriolella violacea)
  - Chilean croaker (Cilus gilberti)
  - Flatfish

Aquacultural Applied Engineering

Sizing and Operation of Aquaculture Facilities

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