Growth, body composition and nutrient loadings of olive flounder

EP, MP and SMP,
Which type of feed should be applied to marine fish farming ?

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Contents

History of Seawater Fish Farming in Korea

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Opening

Early 1970
natural seed capture

Temporary stocking

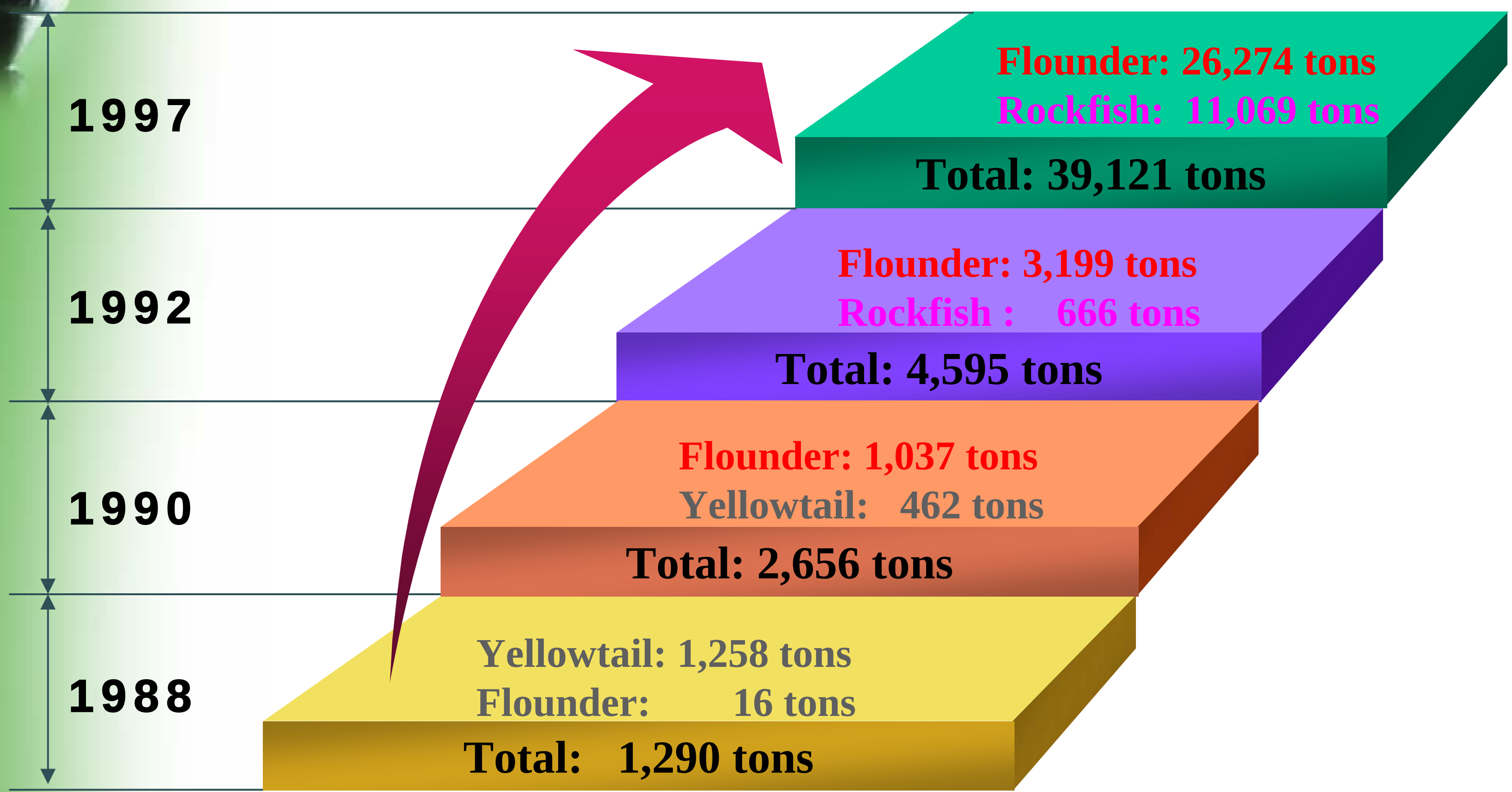
Mid-1980's
yellowtail stocking using a net-cage

Practical farming

- year 1990
  flounder seed production technique
- year 1992
  rockfish farming

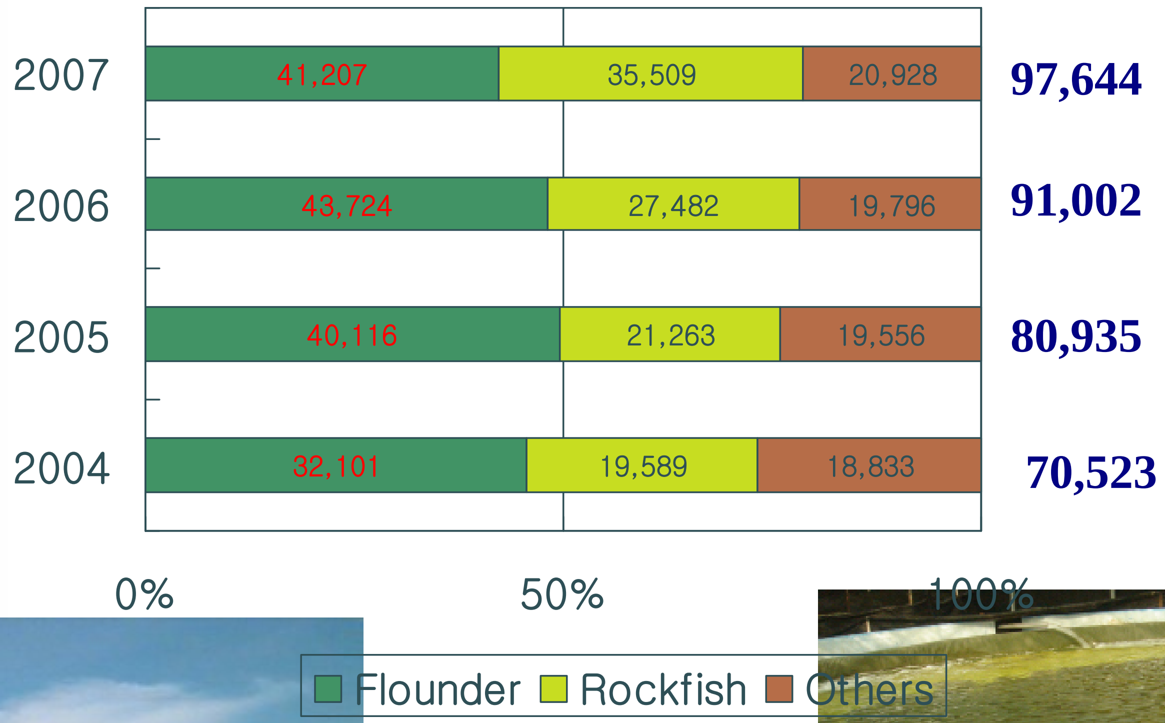
Seawater fish farming

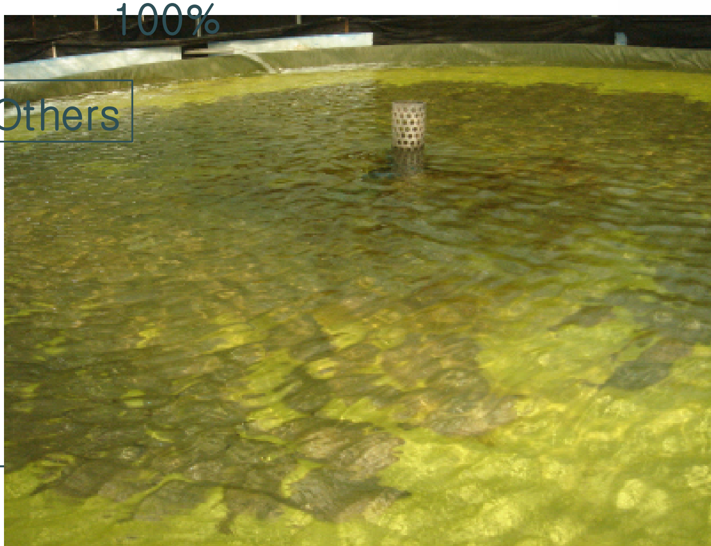
Production History



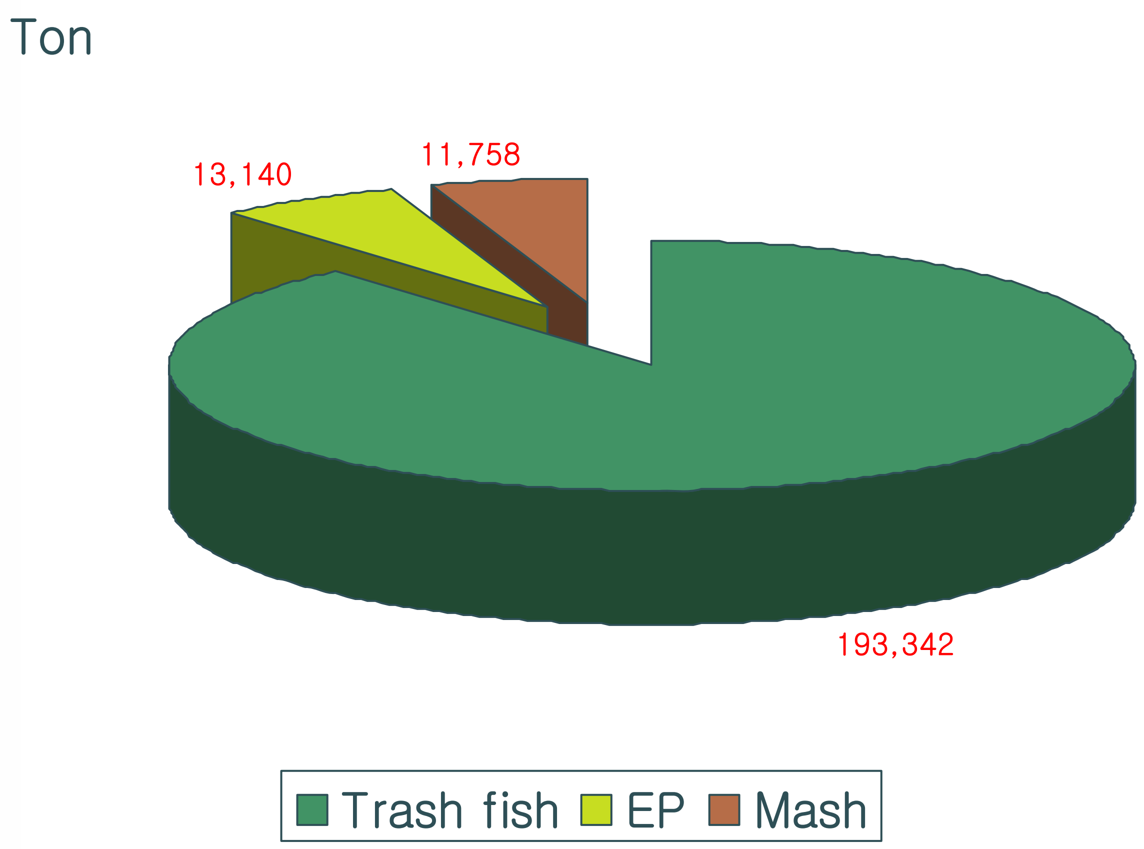
Korean Fisheries Yearbook
1989,1991,1998-1999

Marine culture fish production (MT) from 2004 to 2007





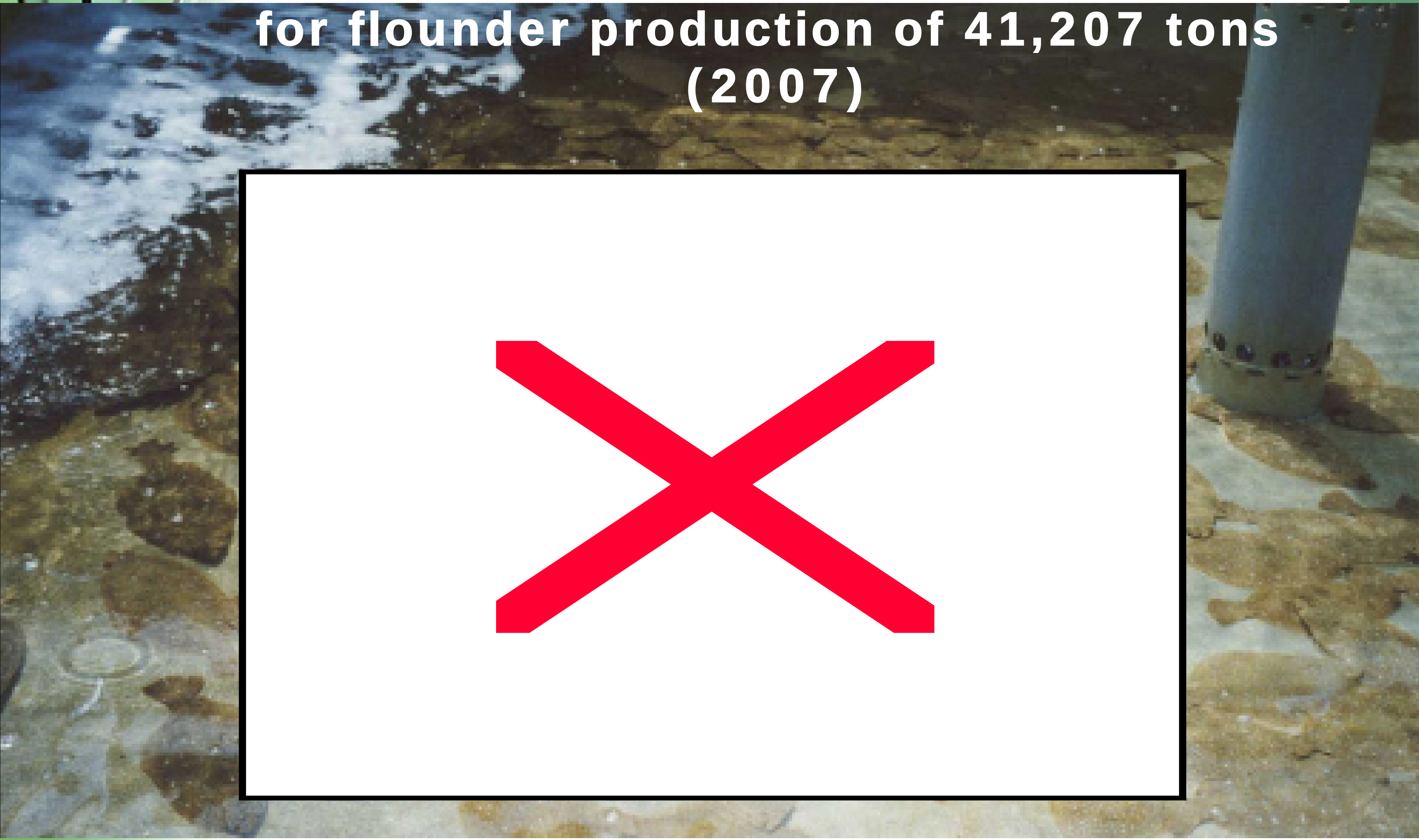
Types of Feed and their amounts used for marine fish farming in Korea (1996 to 2007)



Flounder farming in Korea

696 farms (235 ha)

Feeds used
for flounder production of 41,207 tons (2007)



MP manufacturing

Conventional MP feeding

Nutrient Loadings
g / kg wt gain

N < 60 g
P < 10 g

Backgrounds to develop a new type diet for flounder

- Kim and Lee (2000) compared a conventional MP and two commercial extruded feed (EP) with semi-moist pellet (SMP) made by adding water to formulated feed mixture. It was found that weight gain of flounder fed MP and SMP was not significantly different each other and superior ($P<0.05$) to that of fish fed the EP.

- Similar results were also reported in bigger flounder fed SMP (Kim, 2000).

- In such studies, fish fed commercial EP showed a growth rate much lower than fish fed MP or SMP, suggesting **a necessity of diet development meeting fast growth and low water pollution.**

Objective :

- To compare a newly developed EP
  with conventional MP and SMP
  in terms of growth,
  whole body and muscle composition,
  and nutrient loadings

Items of investigation

- Weight gain
- Feed consumption
- Nutrient intake
- Feed conversion ratio
- Protein efficiency ratio
- Specific growth rate
- Body and muscle composition
- Retention efficiency of N and P
- Loadings of N and P

Materials & Methods

Diet
- MP
- SMP
- EP

Animal

olive flounder (*Paralichthys olivaceus*) of 123 g

Water

Salinity, 33-34 ppt
DO 5.5-6.1 mg/l
Ammonia ~0.05 ppm,

Analysis

- Proximate composition AOAC(1980)
- Amino acids

Design of the experimental diets

- Based on protein (55%) and lipid (18%) levels of MP on dry matter basis, EP was designed to maintain the same level of protein (55%) and a half level of lipid (9%) as MP, while SMP a half level of lipid (9%) with concomitant increase in protein (64%).

- MP was composed of 90.1% raw fish, 4.7% powdered and other additives.

- EP was composed of fish meal of 55.0%, wheat flour of 16.0%, soybean meal of 11.5%, squid liver powder of 5.0%, corn gluten meal of 5.0%, fish oil of 5.0% and others of 2.5%.

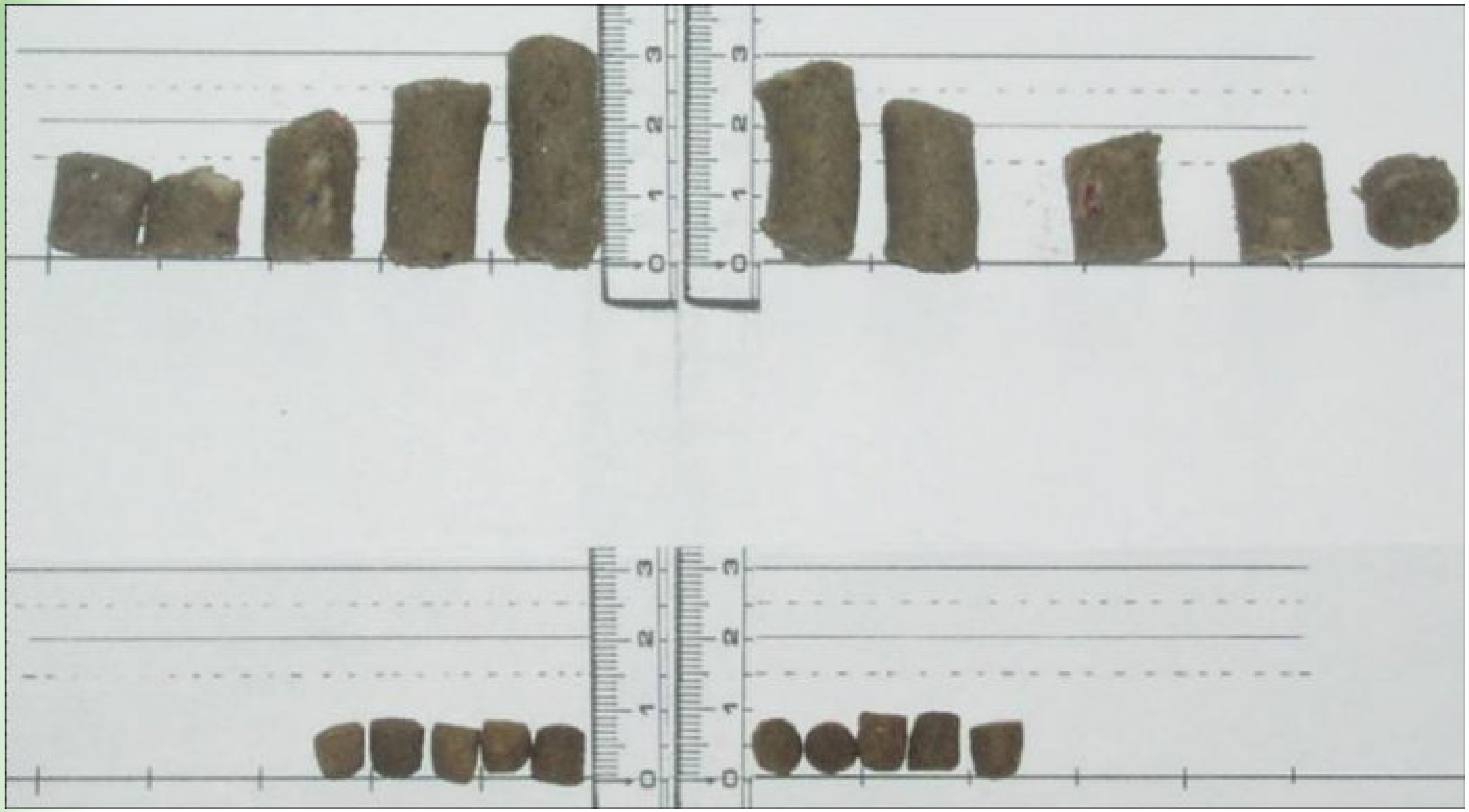
- SMP was composed of fish meal of 72.0%, wheat gluten of 11.5%, corn gluten meal of 5.0%, squid liver powder of 4.0%, wheat flour of 3.5%, fish oil of 2.0% and others of 2.0%.


SMP

Rearing tank
(3.8m x 3.7m x 0.5m, 7 tons/water in tank)

- Flow rate: 150 L/min
- Water temperature: 16~18 ℃
- Water pumped from the sea (50%)
  + seawater from the hydroelectric
    power plant (50%)

Particle size of MP and EP



Daily feed allowances

- Based on the level of 1% of total fish weight, diets were divided into two meals in plastic containers and fed at 9 am and 3 pm.
- Each meal was fed by hand on the water surface until apparent satiation was achieved.
- The weight of MP and SMP left after every feeding were recorded and discarded.
- All diets fed were considered consumed. Daily feed allowances were weekly increased following an estimated weight gains based on feed conversion of 2.
- The number and weight of dead fish were recorded to correct weight gain and feed intakes of the fish group affected.

Analytical methods

- AOAC (1990) procedures: dry matter by drying for 24h at 110 °C; crude protein (N x 6.25) by the Kjeldahl method after an acid digestion; crude lipid after ether extraction following acid (4N HCl) hydrolysis (Tecator Soxtec System, Hoeganaes, Sweden); crude ash by incineration in a muffle furnace at 550°C for 24 hours; Ca by a wet ash method and titration with $KMnO_4$ and phosphorus by a spectrophotometric method using molybdovandate reagent; crude fiber by digestion with 1.25% H_2SO_4 and 1.25% NaOH solutions.

- Gross energy was determined using an adiabatic bomb calorimeter (Parr Instrument Company, Moline, IL, USA).

- Amino acid in diets were analyzed after acid hydrolysis as previously described by Kim and Lall (2000). Tryptophan was determined by the calorimetric method of Basha and Roberts (1977) after alkaline hydrolysis of each sample.

- The results were subjected to analysis of variance; where appropriate, differences between treatment means were determined at the 5% probability level using Duncan's new multiple range test, as described by Steel and Torrie (1960).

Results & Discussion

Table 1. Chemical composition of the experimental diets

Composition	EP	SMP	MP
Proximate composition (g or kJ/100 g DM)			
C. protein	55.7	63.2	54.3
C.lipid	10.0	9.5	17.7
C.ash	11.1	9.6	11.3
C.fiber	1.1	0.5	1.0
Ca	3.0	4.2	4.5
P	1.4	1.5	1.1
Gross energy	2,143	2,212	2,194
Essential amino acid composition (% protein)			
Lysine	6.64	6.32	6.21
Arginine	5.77	5.59	5.36
Histidine	3.02	2.91	2.39
Isoleucine	4.39	4.54	4.35
Leucine	7.93	8.26	7.10
Methionine+cystine	3.46	3.19	3.34
Phenylalanine+tyrosine	7.30	7.46	6.72
Threonine	4.02	3.97	4.17
Valine	5.47	5.40	5.46
Tryptophan	1.03	1.18	1.26

Table 2. Growth and feed utilization of olive flounder fed the experimental diets for 8 weeks[1]

Diet	EP	MP	SMP
Initial wt. (g/fish)	124.4±9.29[ns]	124.1±5.65	122.3±0.3
Wt. gain (g/fish)	103.9±3.73[b]	68.9±0.48[c]	111.1±0.45[a]
Total feed intake (g/fish)			
As-fed	82.0±0.34[c]	219.6±7.86[a]	157.2±3.09[b]
DM	77.4±0.33[b]	65.0±2.33[c]	90.9±1.79[a]
FCR[2]			
As-fed	0.79±0.03[c]	3.19±0.09[a]	1.41±0.03[b]
DM	0.75±0.02[c]	0.94±0.03[a]	0.82±0.02[b]
PER[3]	2.41±0.08[a]	1.95±0.06[b]	1.93±0.05[b]
SGR(%/day)[4]	1.10±0.08[a]	0.78±0.03[b]	1.14±0.01[a]
Mortality[5]	1.10±0.50[b]	3.20±0.80[a]	1.10±0.10[b]

[1]Values (means±SE of two replicates) in the same row sharing a common superscript were not significantly different (P>0.05); ns= nonsignificant.
[2]Feed conversion ratio = feed intake (as-fed or DM)/wet weight gain.
[3]Protein efficiency ratio = wet weight gain/protein intake.
[4]Specific growth rate = (ln(final wt.)-ln(initial wt.))/duration(56 days) x 100.
[5]Mortality (%) = (No. of dead fish/ No. of initial fish) x 100.

Table 3. Whole body composition (g or kJ/100 g) of olive flounder fed the experimental diets

Diet	Moisture	Protein	Lipid	Ash	Ca	P	GE
EP	74.0±0.38^{ns}	18.0±0.33^{a}	3.4±0.14^{b}	3.1±0.16^{b}	1.23±0.04^{b}	0.50±0.02^{a}	729±21.0^{ns}
MP	74.0±0.01	17.5±0.11^{b}	3.8±0.19^{a}	3.7±0.16^{a}	1.50±0.09^{a}	0.48±0.00^{ab}	725±16.5
SMP	74.5±0.63	17.9±0.24^{a}	3.2±0.13^{b}	3.6±0.22^{a}	1.33±0.01^{b}	0.47±0.01^{b}	708±19.3
Initial	75.1±0.10	18.1±0.01	1.9±0.11	4.5±0.08	1.24±0.10	0.63±0.02	605±1.5

Table 4. Utilization of nitrogen and phosphorus by olive flounder fed the experimental diets for 8 weeks[1]

Diet	EP	MP	SMP
Nitrogen			
Intake, g/fish	6.91±0.03^{b}	5.65±0.20^{c}	9.20±0.18^{a}
Gain, g/fish	2.96±0.12^{a}	1.80±0.05^{b}	3.11±0.07^{a}
NRE, %[2]	42.9±1.56^{a}	32.0±0.18^{c}	33.8±0.15^{b}
Excretion, g/kg wt. gain	38.1±2.24^{b}	55.8±1.75^{a}	54.8±1.18^{a}
Phosphorus			
Intake, g/fish	1.05±0.00^{b}	0.72±0.03^{c}	1.38±0.03^{a}
Gain, g/fish	0.36±0.01^{a}	0.14±0.01^{b}	0.33±0.02^{a}
PRE, %[3]	34.2±1.57^{a}	19.9±0.77^{c}	23.6±1.10^{b}
Excretion, g/kg wt. gain	6.65±0.05^{c}	8.42±0.16^{b}	9.51±0.09^{a}

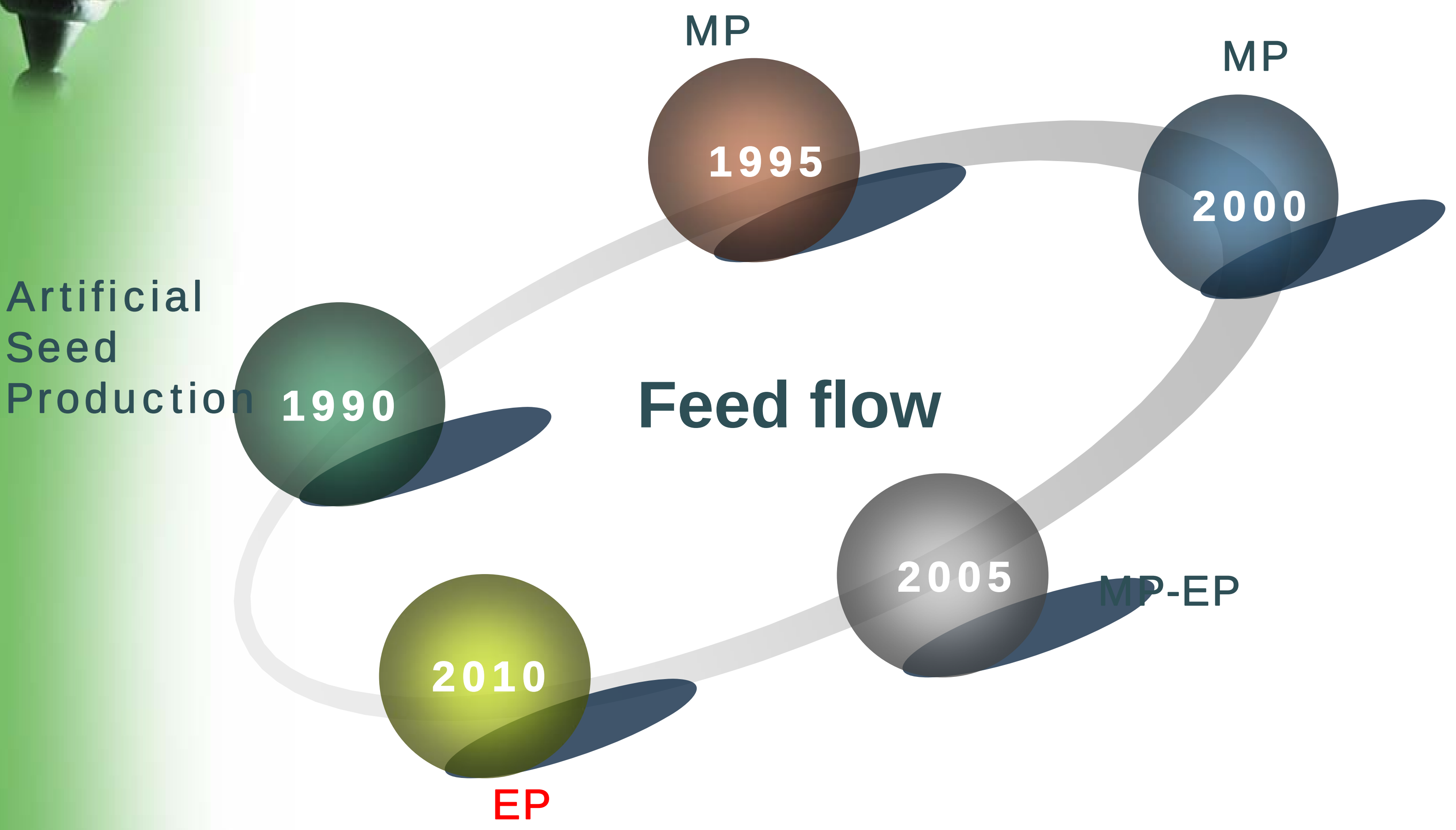
[1]Values (means±SE of two replicates) in the same row sharing a common superscript were not significantly different ($P>0.05$).
[2]Nitrogen retention efficiency= N gain/N intake x 100.
[3]Phosphorus retention efficiency= P gain/P intake x 100.

Table 5. Eye-side muscle composition (g / 100 g) of olive flounder at the end of the experiment[1]

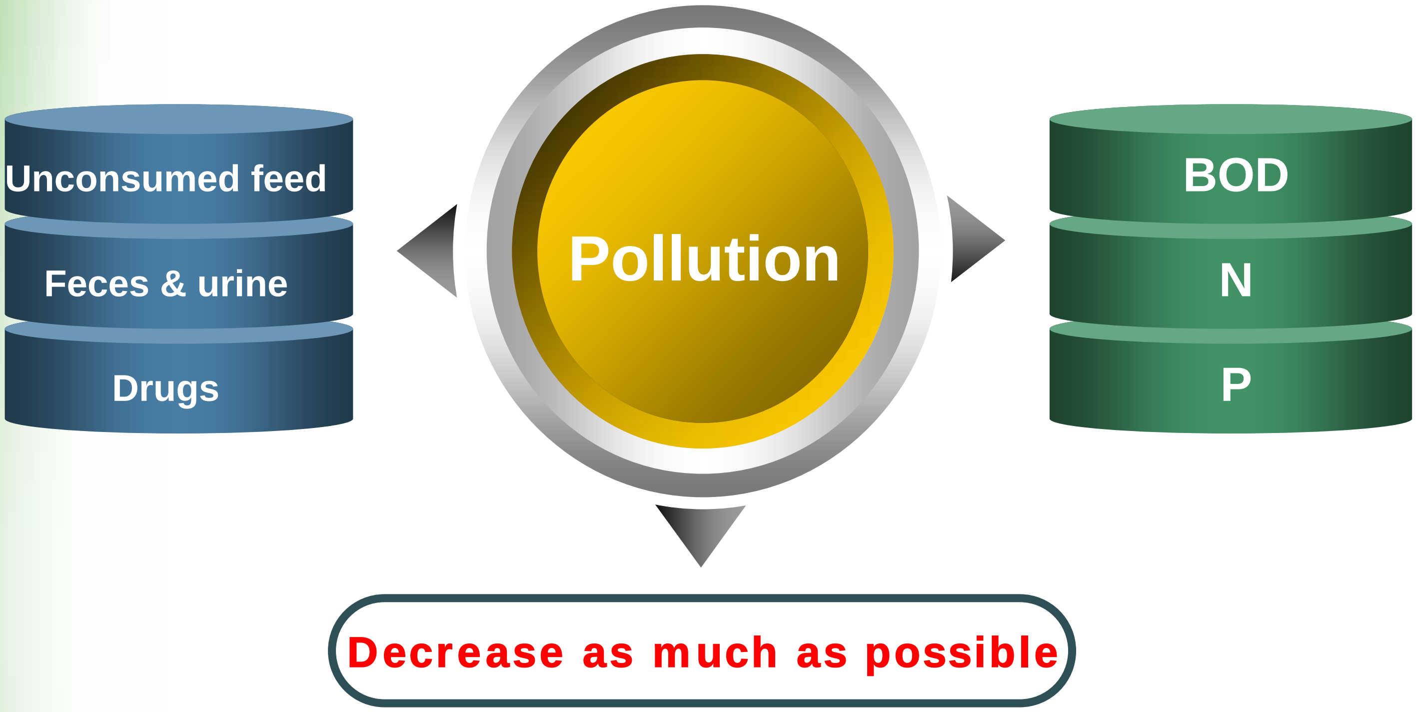
Diet	Moisture	Protein	Lipid	Ash	Ca	P	Ca : P
Dorsal muscle							
EP	76.3±0.12^{ab}	20.9±0.16^{b}	0.48±0.06^{ns}	1.34±0.01^{ns}	0.39±0.02^{a}	0.35±0.00^{a}	1 : 0.9
MP	77.0±0.35^{a}	20.5±0.29^{b}	0.57±0.17	1.35±0.04	0.40±0.03^{a}	0.25±0.01^{c}	1 : 0.6
SMP	75.7±0.62^{b}	21.4±0.28^{a}	0.42±0.04	1.37±0.02	0.33±0.01^{b}	0.29±0.03^{b}	1 : 0.9
Ventral muscle							
EP	75.6±0.25^{ns}	21.5±0.01^{a}	0.60±0.03^{ns}	1.33±0.03^{a}	0.38±0.01^{ab}	0.30±0.01^{ns}	1 : 0.8
MP	76.7±0.91	20.9±0.08^{b}	0.66±0.25	1.33±0.00^{a}	0.39±0.01^{a}	0.30±0.01	1 : 0.8
SMP	75.5±0.05	21.5±0.31^{a}	0.43±0.02	1.28±0.02^{b}	0.35±0.03^{b}	0.31±0.00	1 : 0.9

[1]Values (means±SE of two replicates) in the same column sharing a common superscript were not significantly different ($P>0.05$); ns= nonsignificant.

Diet should be swiched !!!



Pollution factors from fish farms



Beyond Carbon:
Scientists Worry About Nitrogen's Effects

algae in Qingdao, China

Conclusion

Use of the EP

Legally established

Protection natural seed stocks

Disease control

Sustainable industry

Safety

We can't support the growth of the aquaculture business using fish to feed fish

Thank You !

Clean sea for next generation !