

Hormones regulating growth and fattiness in salmon

- research towards sustainable feeding in aquaculture

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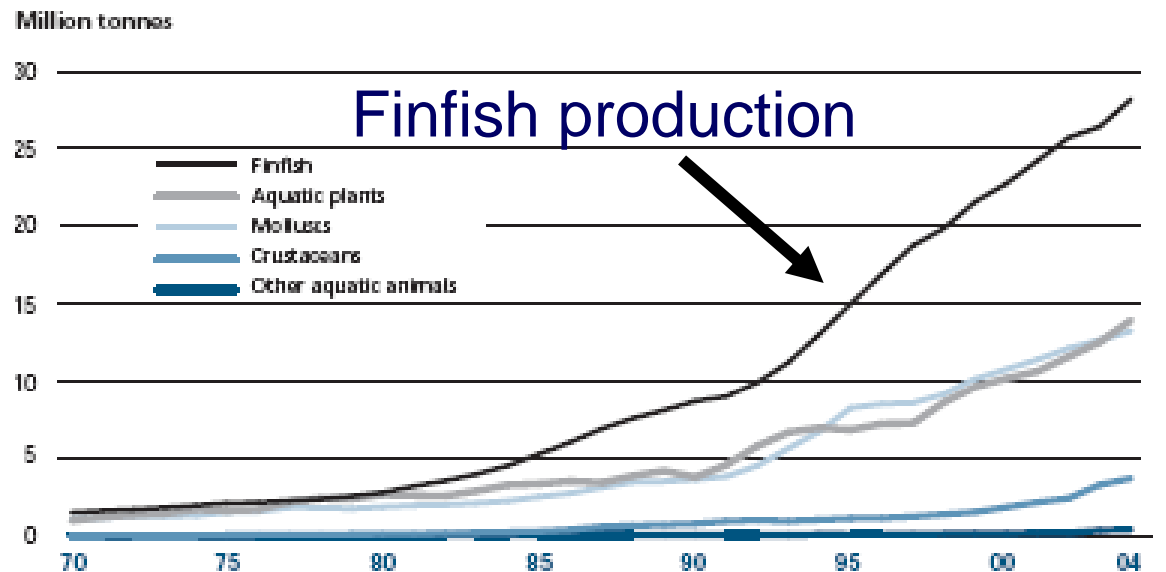


Aquaculture is the fastest growing food-producing sector in the world



Figure 11

Trends in world aquaculture production: major species groups



43% of all fish eaten today is farmed and not wild-caught!

Source: The state of the World Fisheries and Aquaculture (SOFIA), 2006. FAO.

Farming carnivorous species requires input of wild fish for feed



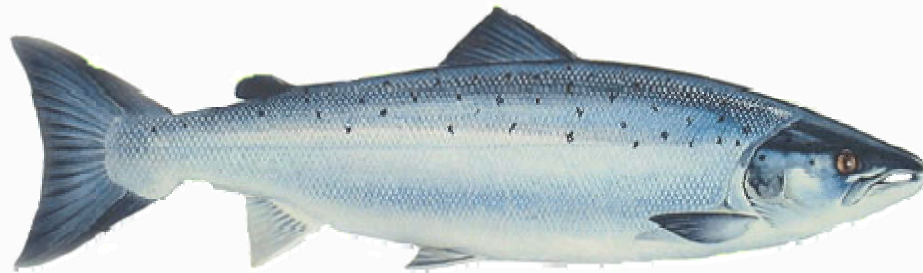
Alternative feed for fish



The replacement of fish ingredients in fish feed with vegetable ingredients must be done without affecting growth, health or quality.

Main research goals

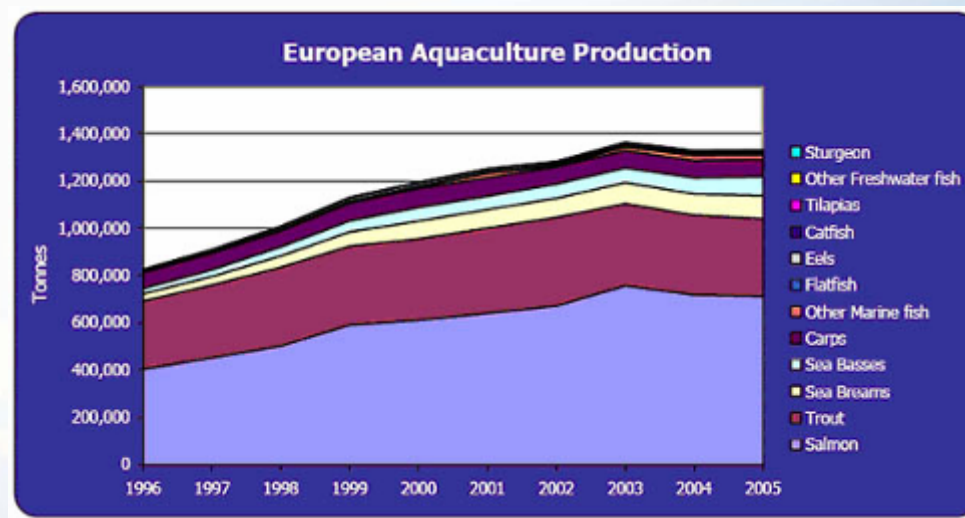
- **Increase basic knowledge on the hormonal regulation of growth and fat deposition in salmonids**
- **Increase the understanding of the nutritional regulation of hormones in salmonids**



Atlantic salmon
Salmo salar



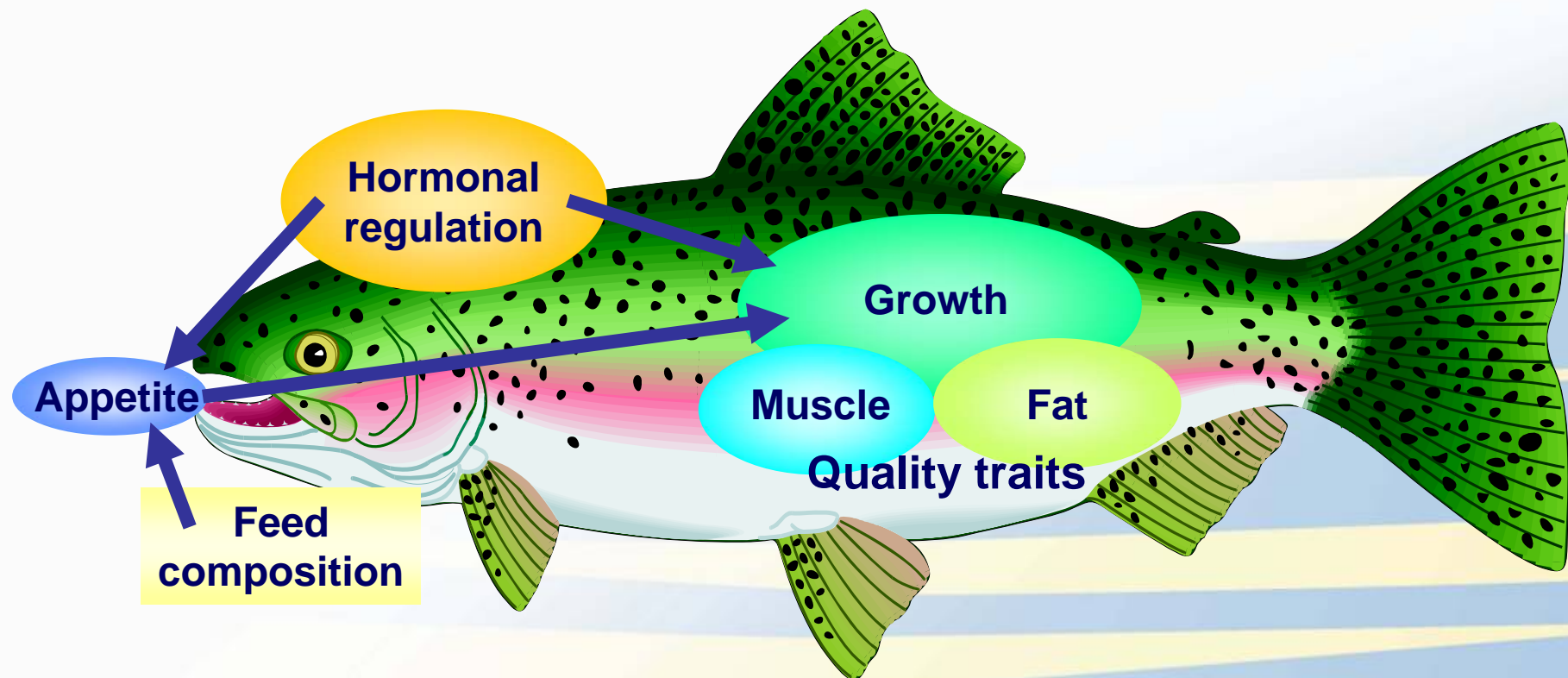
Rainbow trout
Oncorhynchus mykiss



European Aquaculture Production from 1996 to 2005

Credit diagram: FEAP, Federation of European Aquaculture Producers. (<http://www.feap.info/feap/>)

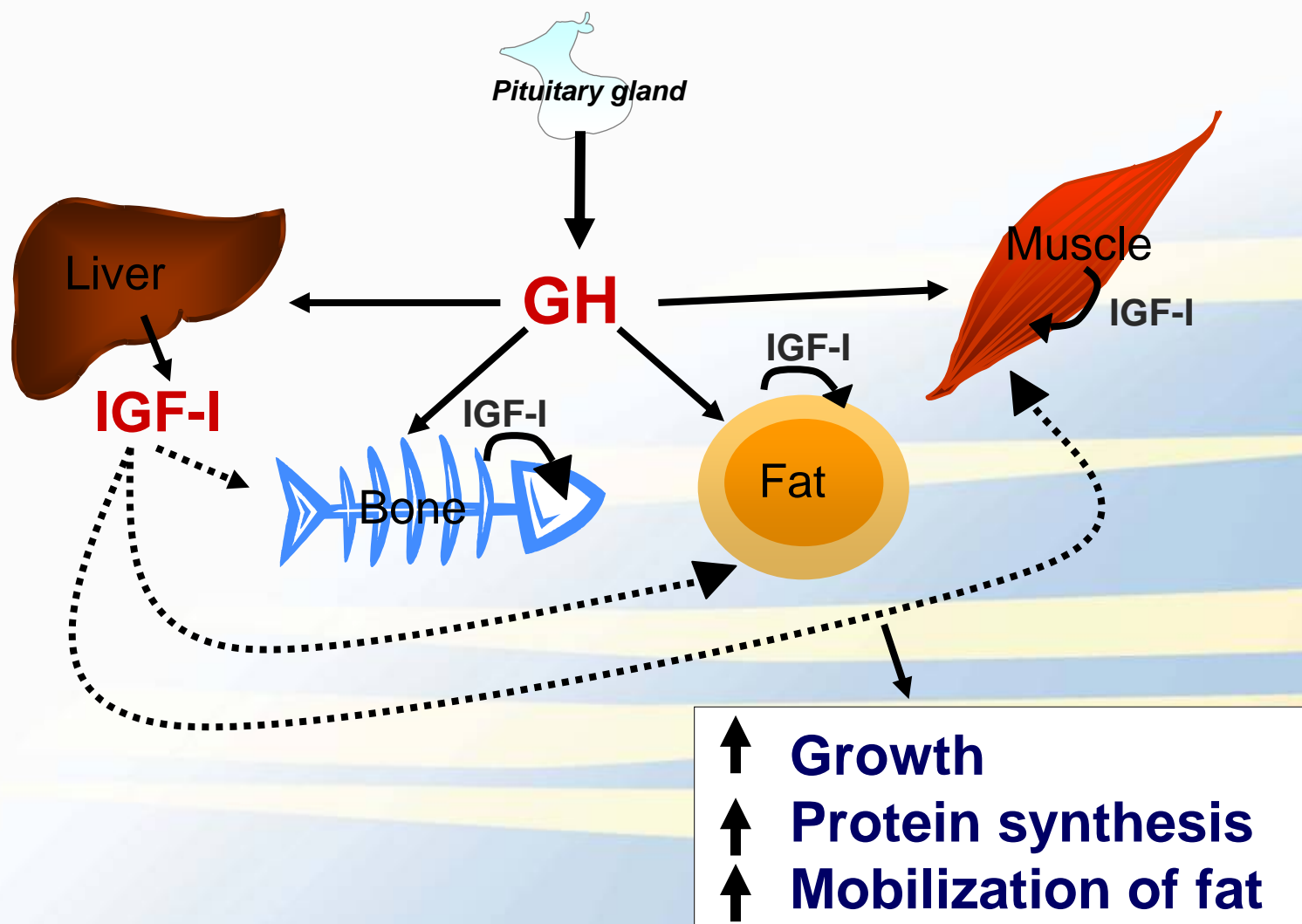
Linking feeding to how physiological mechanisms regulate quality traits



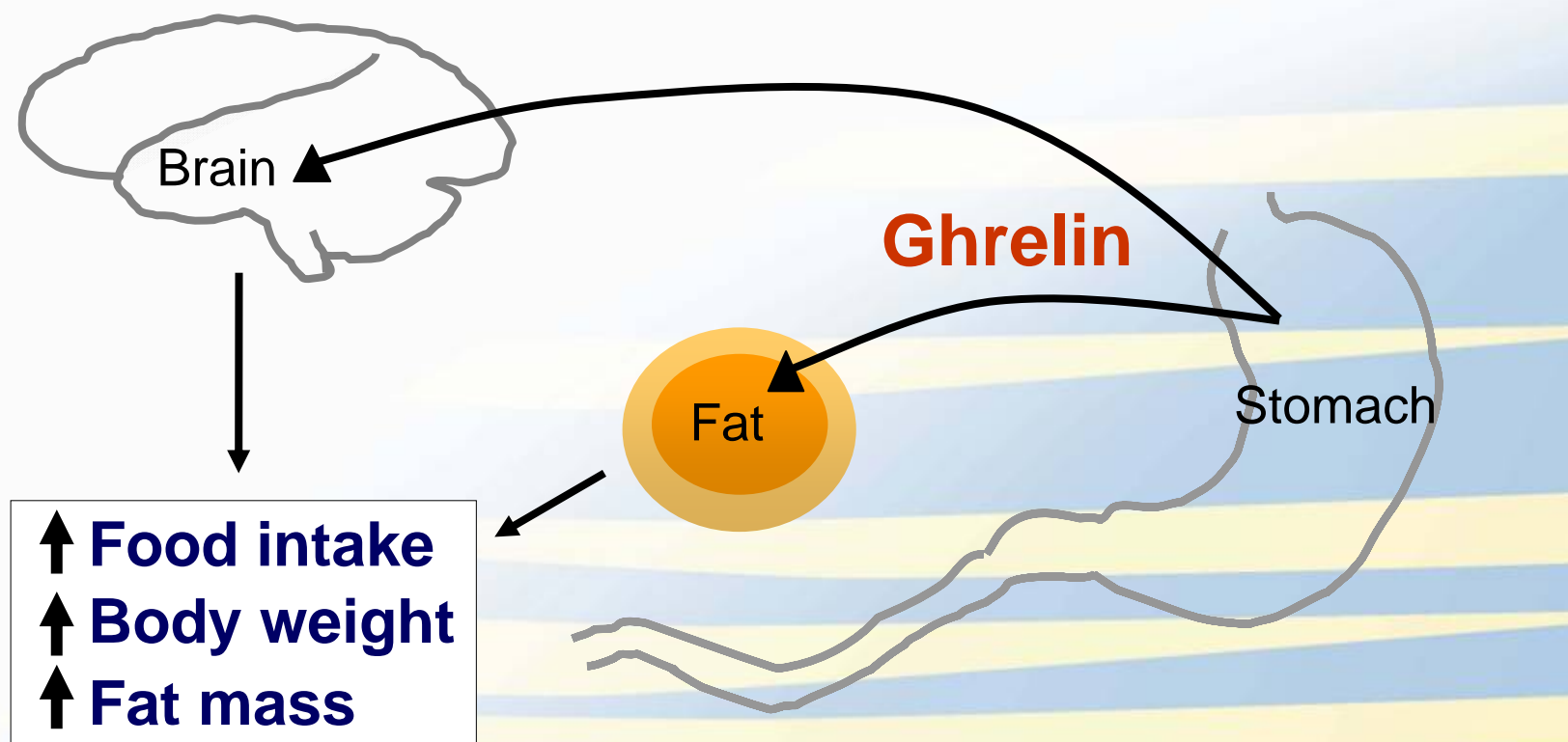
Current key questions

- **What is the role of the novel hormone ghrelin in growth, appetite and fat deposition?**
- **What is the effect of inclusion of vegetable components on growth performance, fat content and GH, IGF-I and ghrelin hormone levels?**

The GH-IGF-I system is fundamental for growth

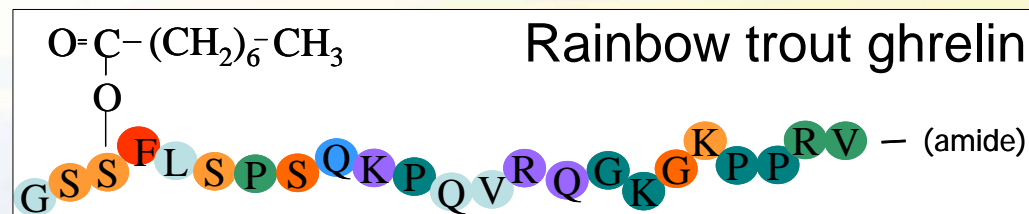


Ghrelin is central for energy balance

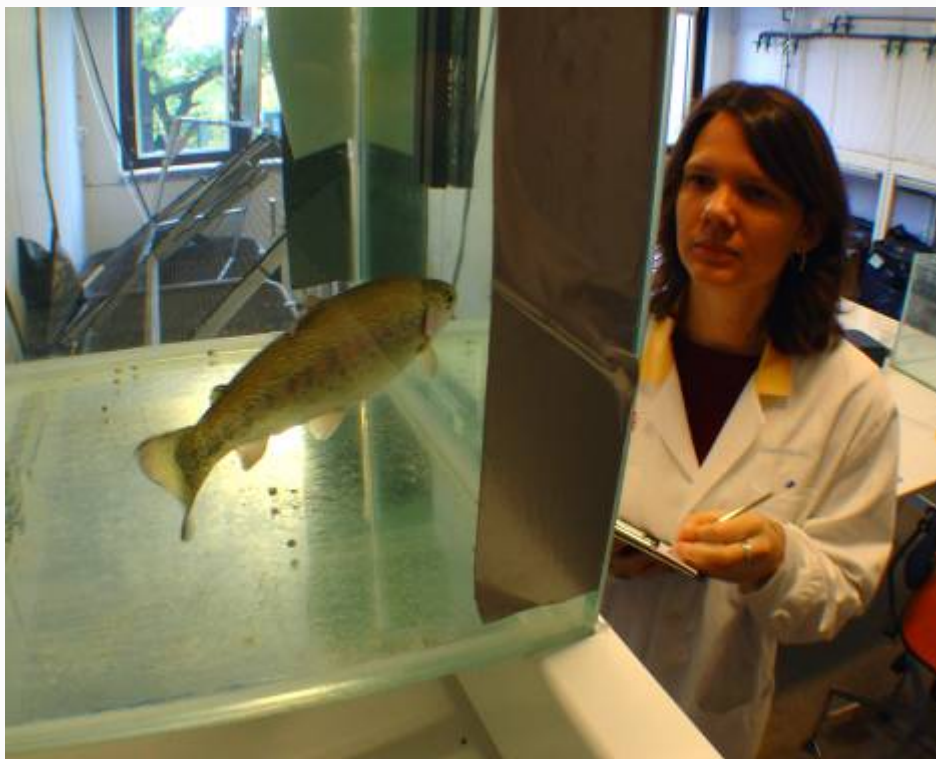


Our initial ghrelin measurements in rainbow trout showed that :

- Ghrelin decreases during fasting
- Ghrelin tends to increase at high dietary fat content
- Ghrelin is positively correlated with body growth and condition factor



Ghrelin treatment studies in rainbow trout

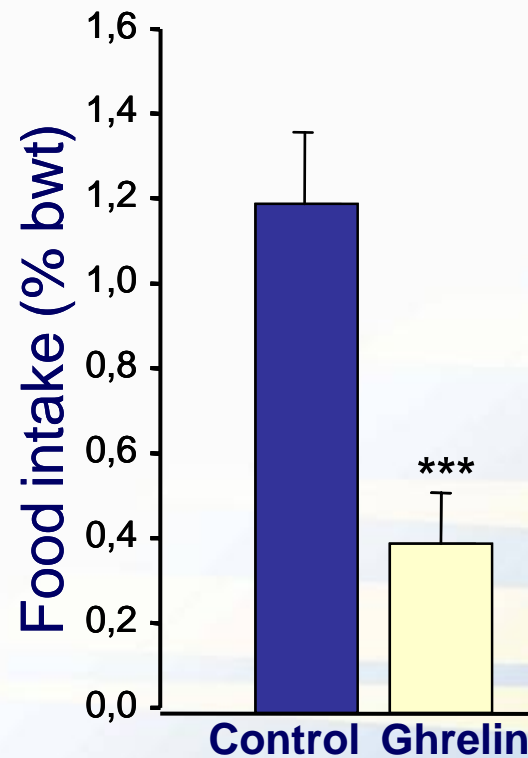


Observing food intake

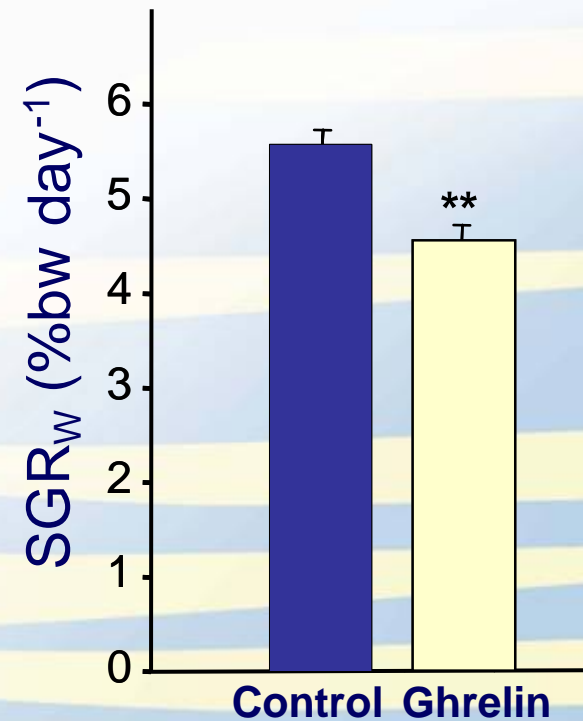
Ghrelin decreased food intake and growth



Food intake

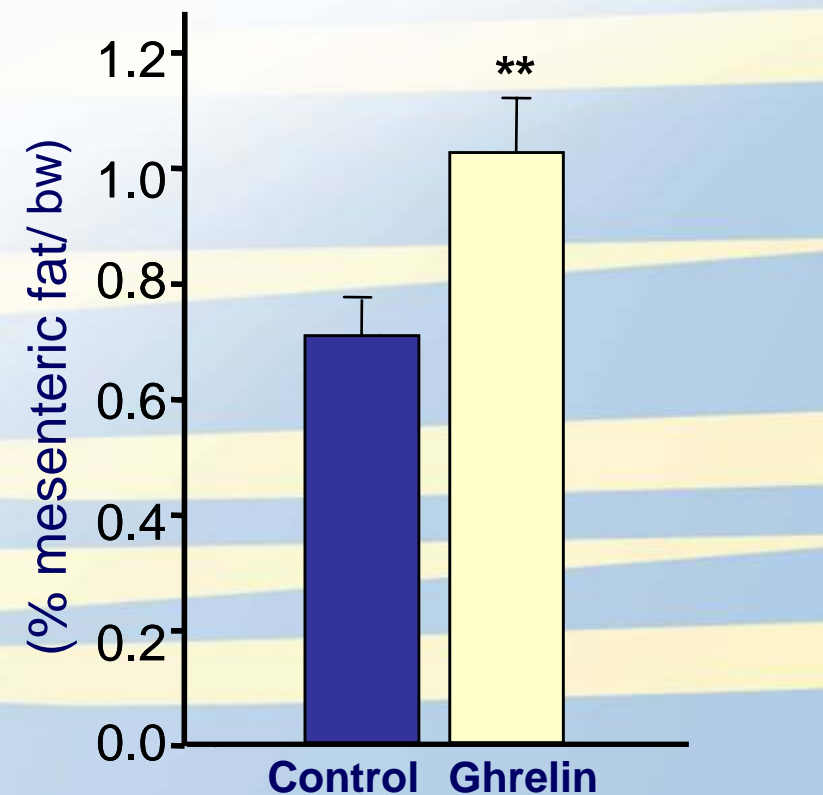


Weight growth rate



Ghrelin increased abdominal fat deposition

Abdominal fat



Replacing fish ingredients with vegetable alternatives in fish feed



- collaboration with NIFA and BioMar



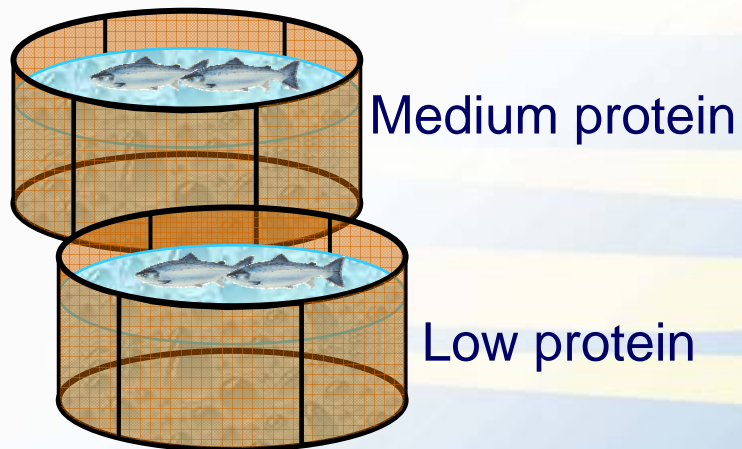
Gildeskål Research Station, Norway

Oil source and protein level -feeding trials during two seasons

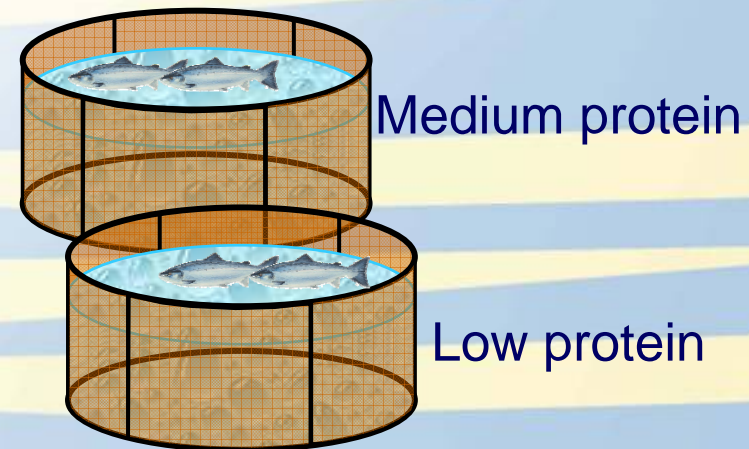


Winter trial: February-April
Summer trial: August-October

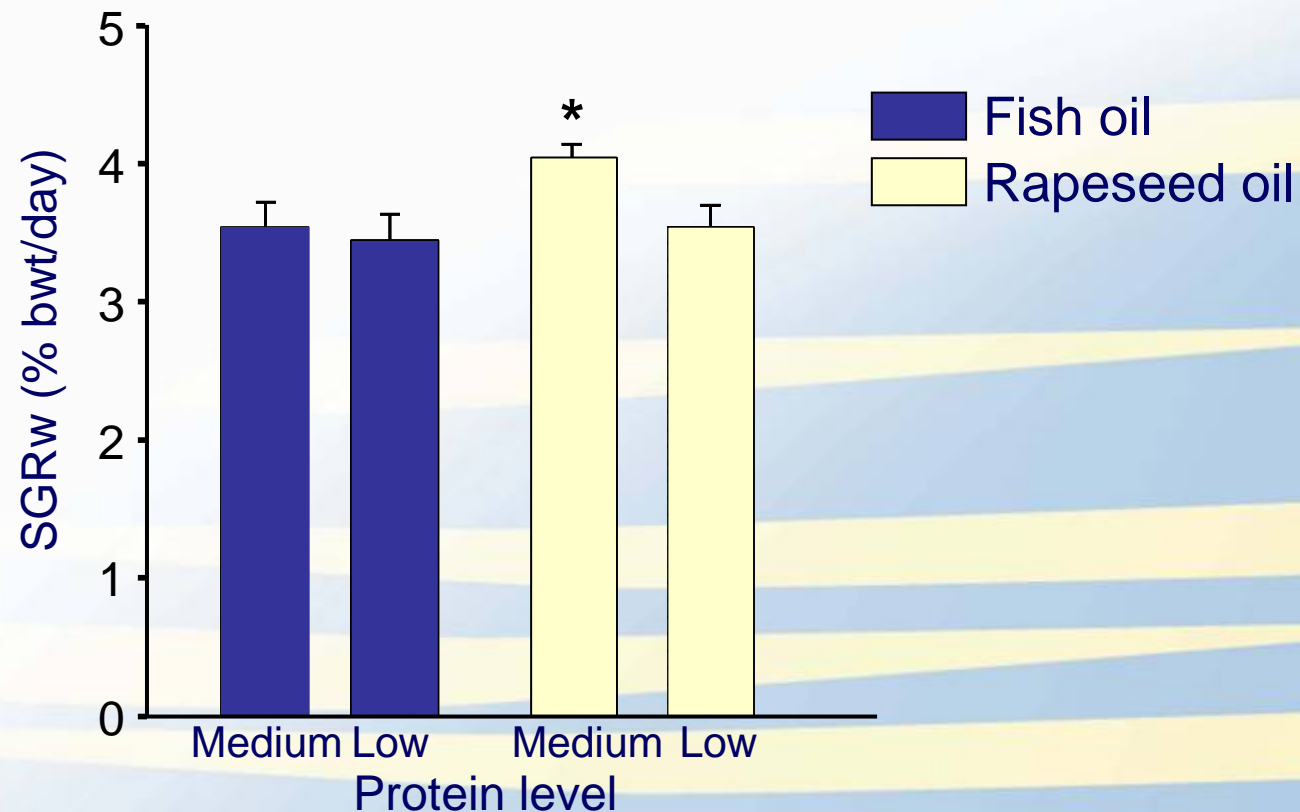
100% Fish oil diet



60% rapeseed oil diet



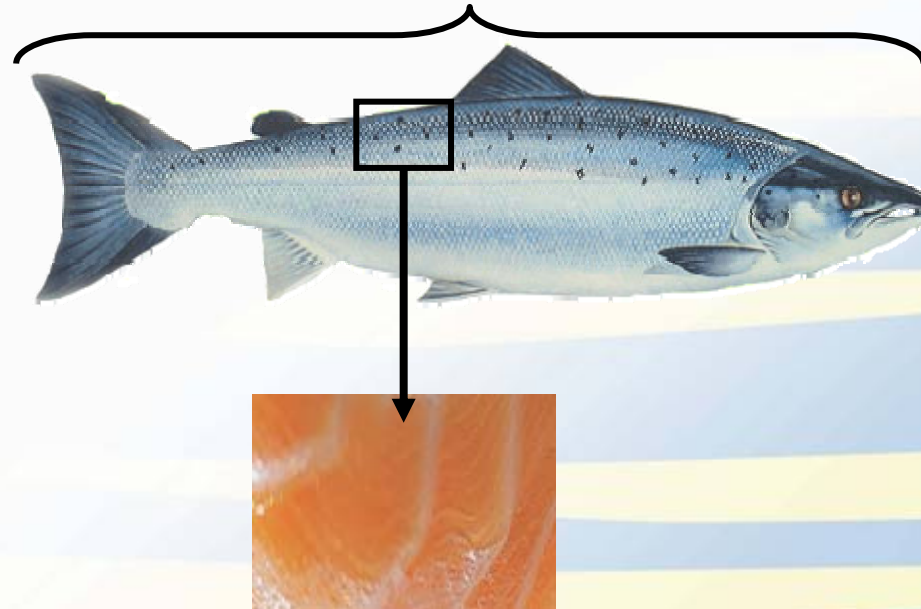
Fish fed diets with rapeseed oil grew faster, but only at medium protein levels



Dietary composition influences fat distribution

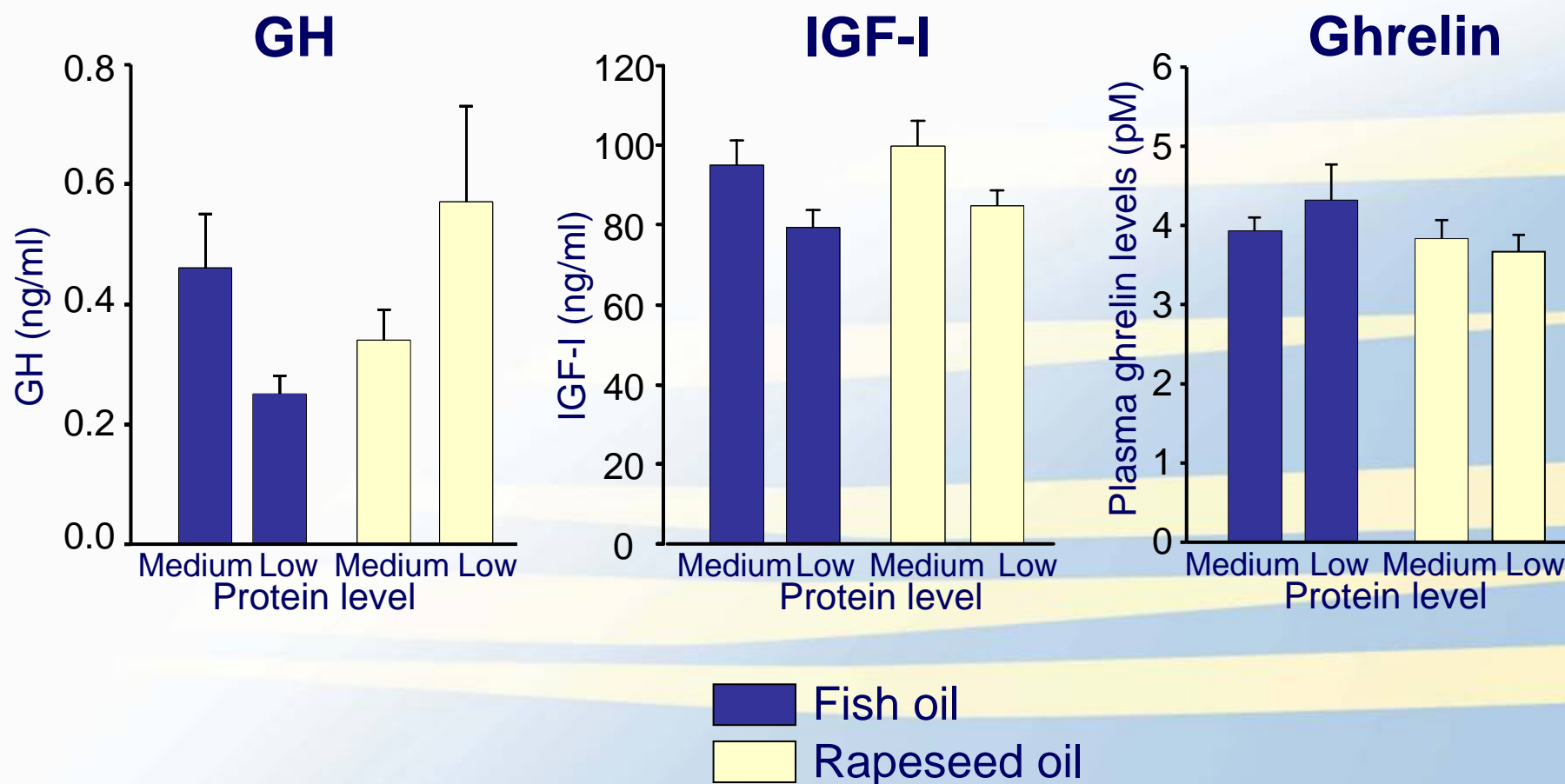


**Whole body fat content
increases by rapeseed oil inclusion**





**Muscle fat content
decreases by low dietary protein levels**

Hormone levels are differently affected by dietary factors



Seasonal effects

- The diet-effects were similar, but more pronounced, in summer compared with winter
- Hormone levels varied between seasons:

	 Winter	 Summer
Ghrelin (pM):	3.9	7.1
IGF-I (ng/ml):	57.1	86.8
GH (ng/ml):	0.9	0.4

Fishmeal replacement study

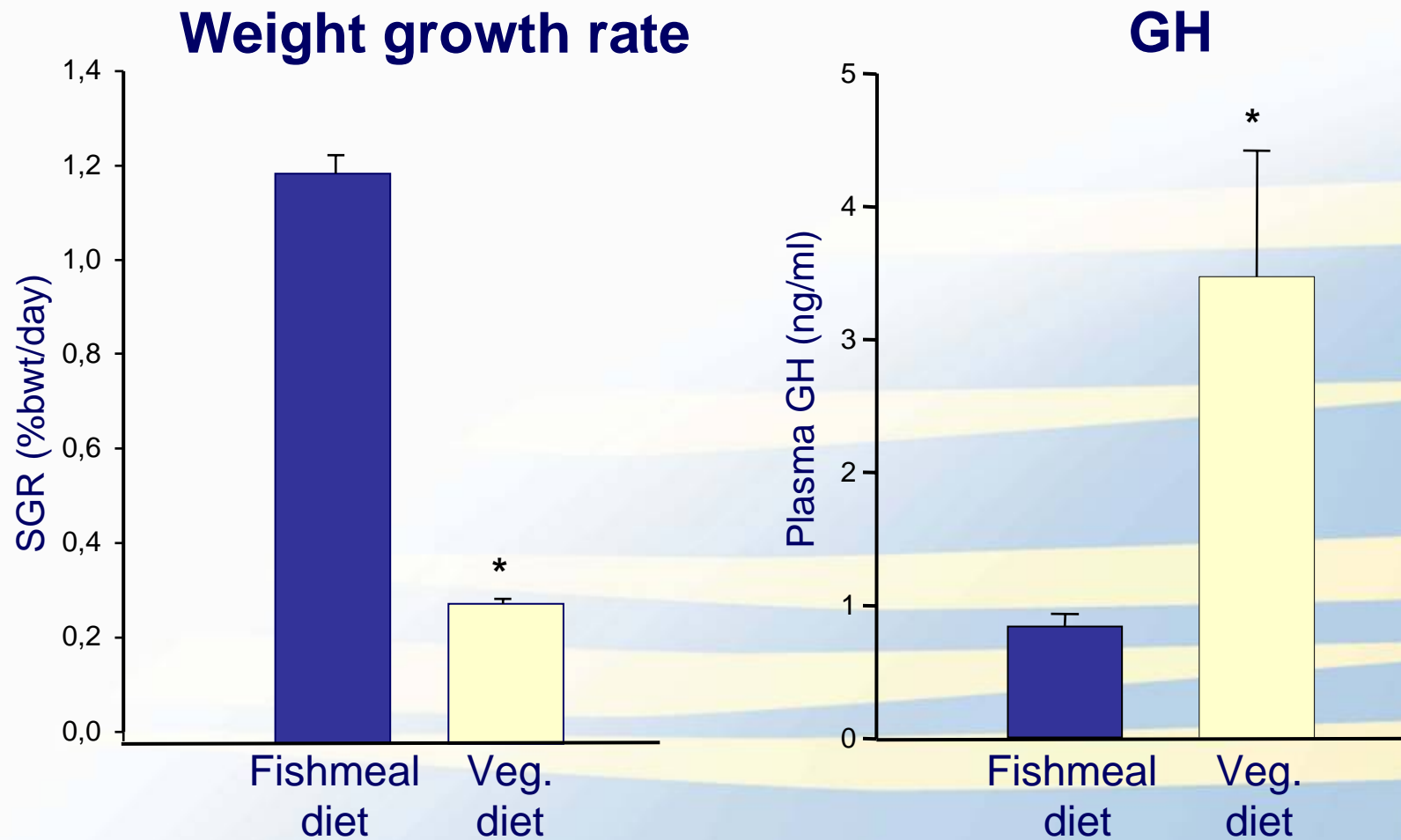


Diets differed in type of protein source:

	Vegetable diet	Fishmeal diet
Vegetable protein:	90%	57%
Fishmeal protein:	10%	43%

Aksnes et al. (2006) Aquaculture, 261, 305-317

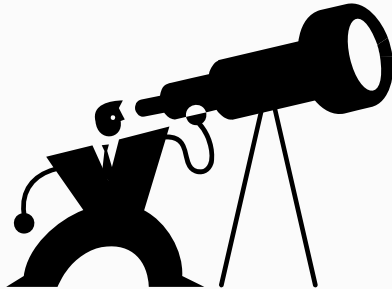
Growth suppression was reflected in GH levels



Aksnes et al. (2006) *Aquaculture*, 261, 305-317

Conclusions

- **GH and IGF-I respond to dietary composition, in particular with regards to protein, and may reveal nutritional imbalance related to impaired growth**
- **Ghrelin decreases food intake and weight growth rate, and at the same time promotes abdominal fat storage**
- **Fish respond differently to different feeds depending on season**



Future vision

- **Tailoring feed to season and environment is important to optimize growth and product quality**
- **This will also lead to a more efficient and sustainable use of resources**
- **To reach this goal, better understanding of seasonal effects on endocrine control and diet responsiveness is needed**

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