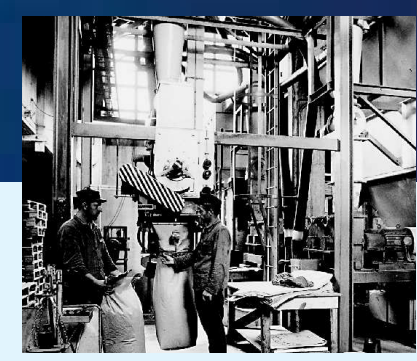




Usage of fish by-products for feed- and foodgrade applications

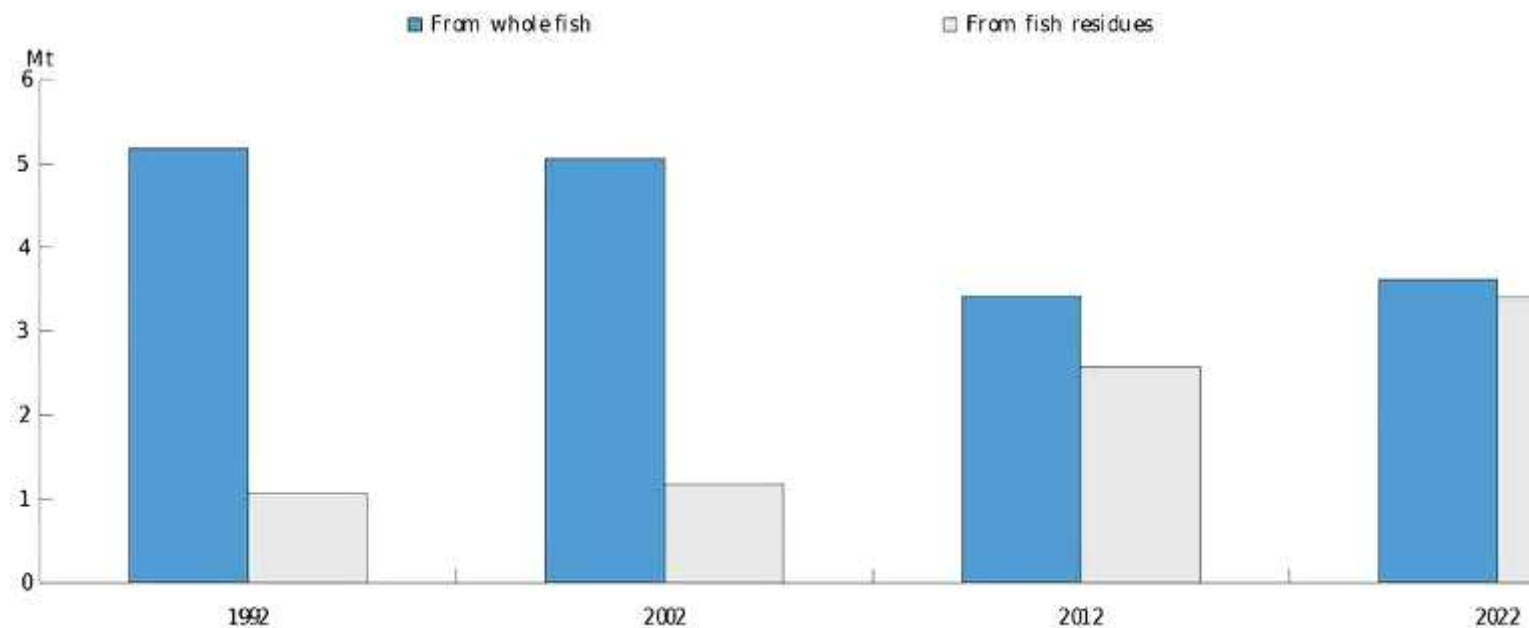


By-products - amount

	Fish from aquaculture total (marine) [Mill. t]	Fish from capture fishery (marine) [Mill. t]
1950	0,32 (0,00)	17 (15)
1960	0,32 (0,00)	31 (28)
1990	0,32 (0,00)	75 (69)
Just 30-50% of the fish from capture and aquaculture arrives on consumers' tables		
2005	28 (3)	80 (71)
2010	38 (3,5)	76 (66)

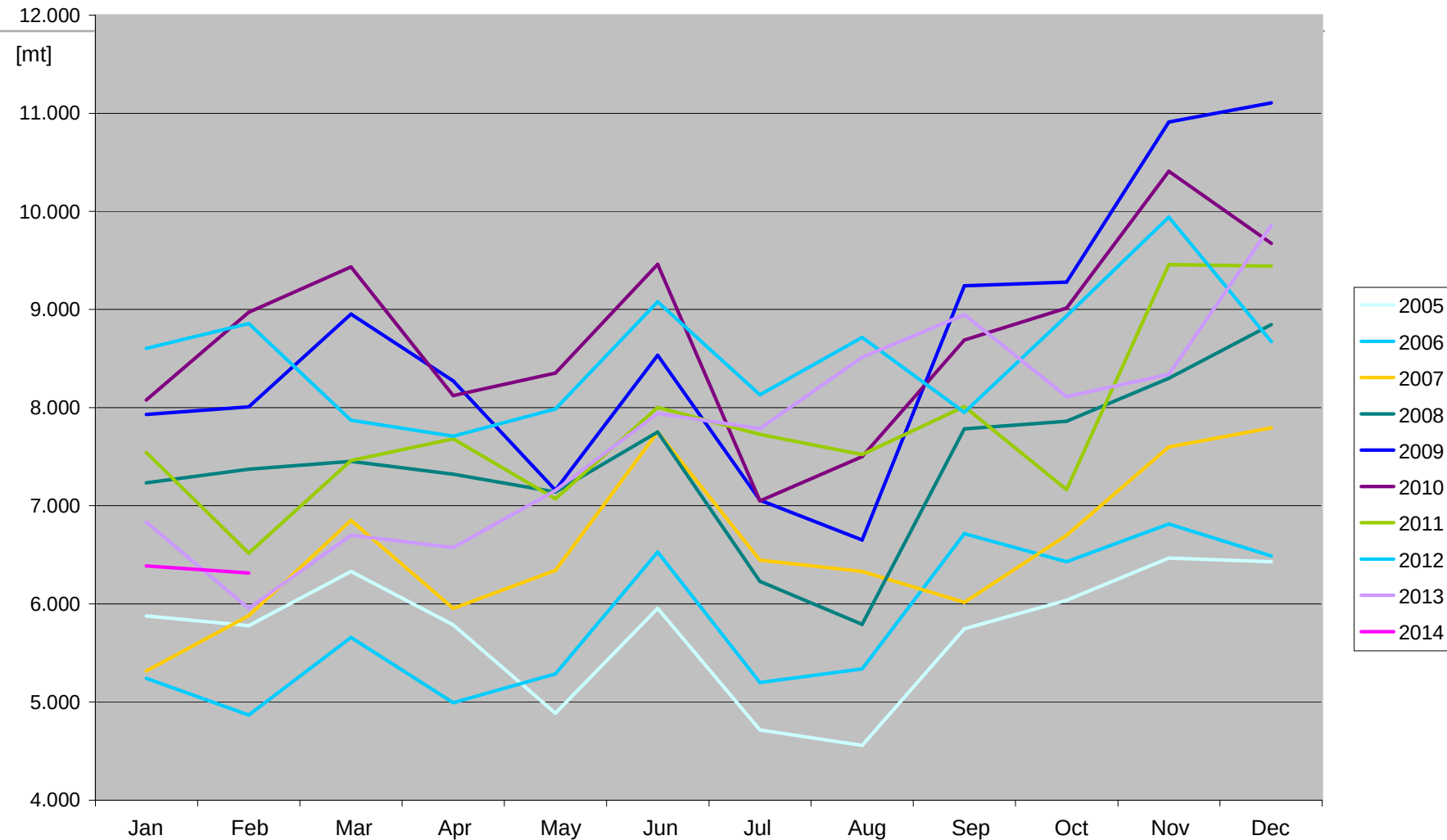
Raw materials used for fish oil and fish meal

	1992	2002	2012	2022
From whole fish	5.1822112	5.0589255	3.4122881	3.6137758
From fish residues	1.0685968	1.1765385	2.5764343	3.4072114

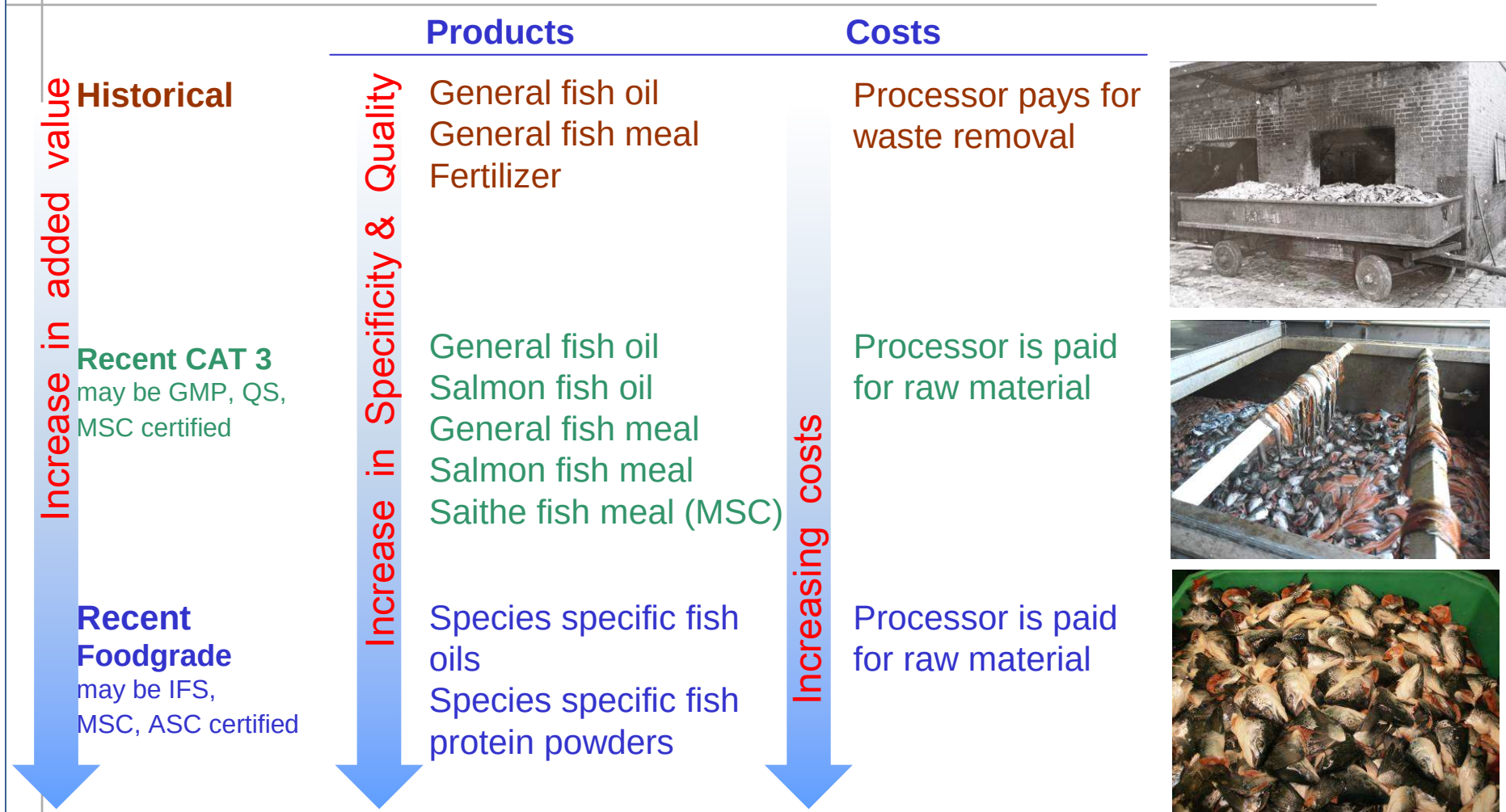


Bioceval: 100% by-products

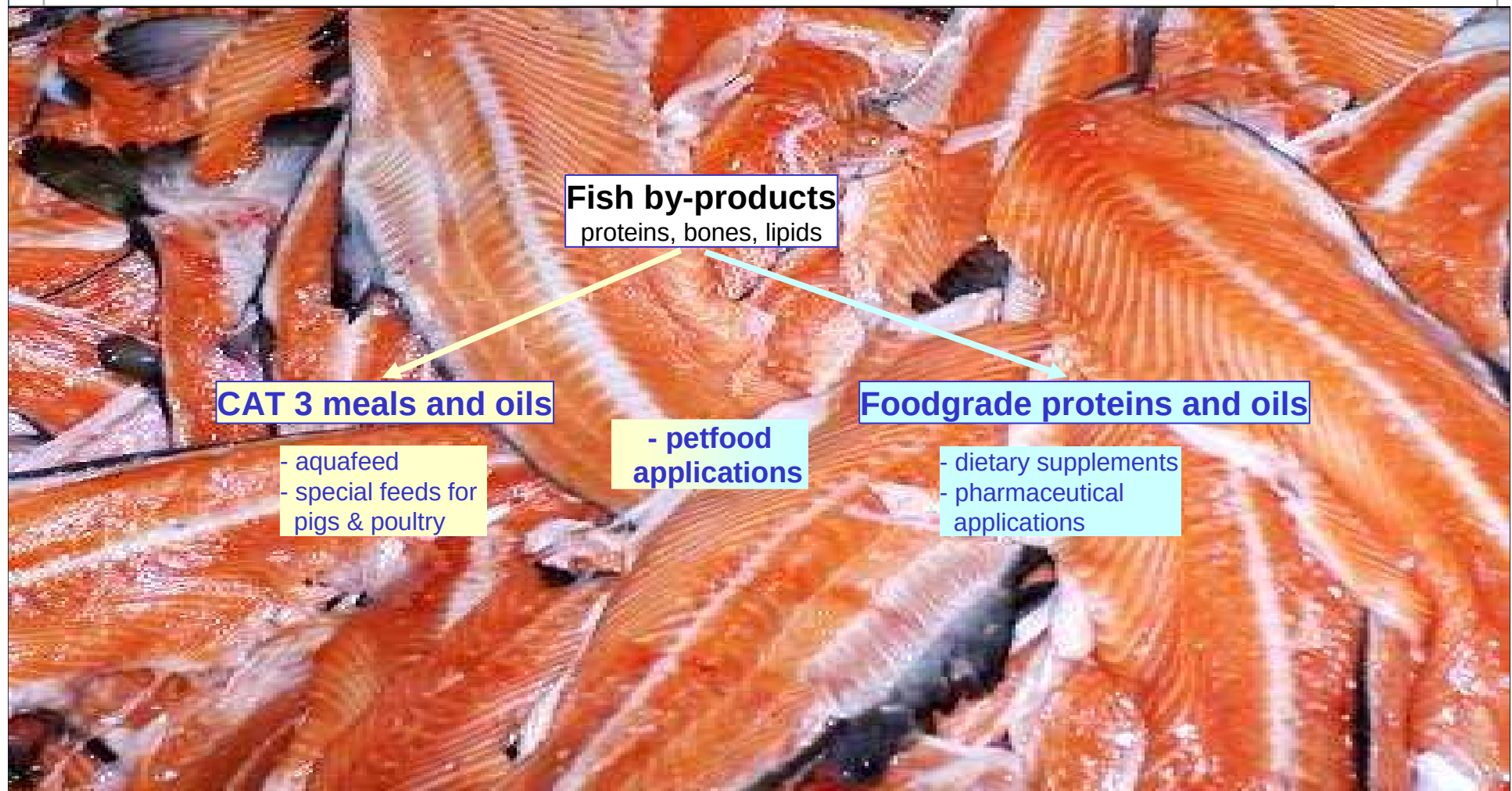
Fish by-products - seasonality



History fish by-products



Potential applications of fish by-products



Cat-3 fish meal and fish oil

aquafeed

- no by-products from farmed fish

- **Fish-meal**

high in protein, high digestibility
low in ash, TVN

- **Fish oil**

high in EPA/DHA
low FFA



Pigs & Poultry

- **Fish-meal**

high in protein, high digestibility
low in ash, TVN

- **Fish oil**

high in EPA/DHA
low FFA



Fish meal and fish oil for petfood

- no ethoxyquine
- fresh raw materials, quality demands comparable to food
- **Fish-meal**
 - high in protein, high digestibility
 - species specific fish meal preferred
 - ASC or MSC certifications preferred
 - low in ash, TVN
- **Fish oil**
 - refined fish oils strongly preferred
 - (refinement includes desodoration as essential step to remove fish odor)
 - species specific fish oil, at best MSC or ASC certified, preferred
 - high in EPA/DHA
 - low FFA



Fish protein for human consumption

- fresh raw materials, must fit food standards (i.e. as fish filets)
- processing must fit hygienic demands for food grade production

- Fish-proteins

+ fish hydrolysate for applications as dietary ingredient or a protein booster

crude protein $\geq 90\%$

must be neutral in odor & taste, color must be white

no intestines allowed in raw materials



+ fish protein for applications as texture enhancer

crude protein $\geq 90\%$

must be functional

no intestines allowed in raw materials



+ fish gelatine or collagen hydrolysate for nutrition and cosmetic industry

crude protein $\geq 90\%$, hydroxyproline content $> 6-10\%$

collagen hydrolysate must be neutral in odor & taste, color must be white

fish gelatine must be functional (= gel forming)

only fish bones and skins allowed in raw materials, no heads, no intestines

+ functional fish peptides for medical applications (e.g. ACE inhibitors)

ongoing research promising

..... introduction into pharmaceutical markets will take time

Fish oil for human consumption

- fresh raw materials, must fit food standards (i.e. as fish filets)
- processing must fit hygienic demands for food grade production
- refined or natural
- 18% EPA / 12% DHA for standard refined fish oil, high in DHA for pregnant and kids
- species specific fish oil, at best ASC or MSC certified, preferred
- fish oil concentrates for pharmaceutical applications

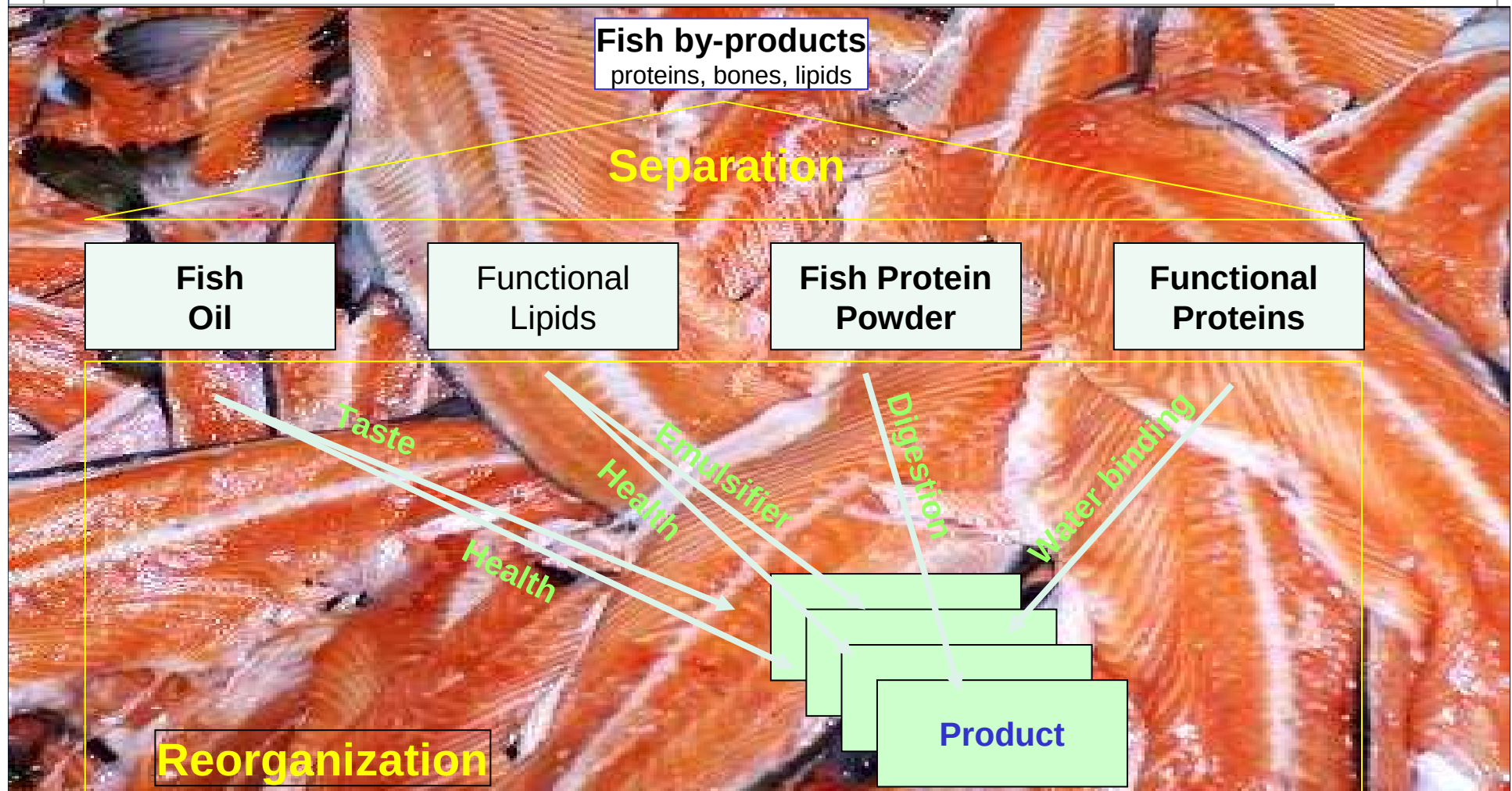


Trends

- access to high quality raw materials is essential for all applications
- sampling and transport of raw materials should imply its quality
- processing must be adapted to allow species specific products of high quality
- processing of food-grade fish proteins and fish oils must fit EC regulations concerning food production and hygienics



Example: LIPROMAR strategy



Lipromar – raw materials



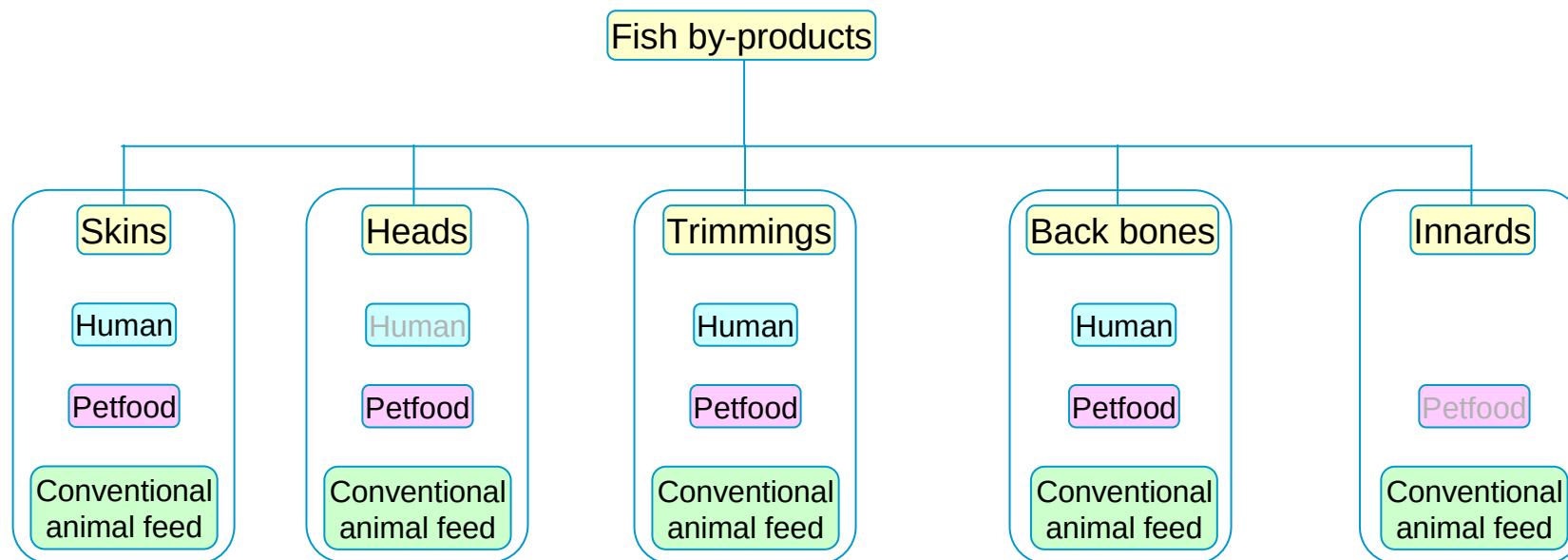
- selected raw materials, species specific sampling
- Delivery cooled or frozen in special isolated containers
- Quality control at arrival
 - + temperature
 - + appearance and odor
 - + TVBN value

Lipromar – processing

- production in a new factory
- established 2011 for fish oil production, extended for fish protein production in 2015
- capacity: about 10.000 t raw materials per year
- 3 shifts a day
- digitally controlled, three employees / shift



Conclusions



- Access to sufficient volumes of high quality by-products is essential
- Trend towards species-specific products
- Trend towards products certified for sustainability
- Promising research on functional peptides for medical applications

Thank you for your attention