Portuguese Institute for Sea and Atmosphere

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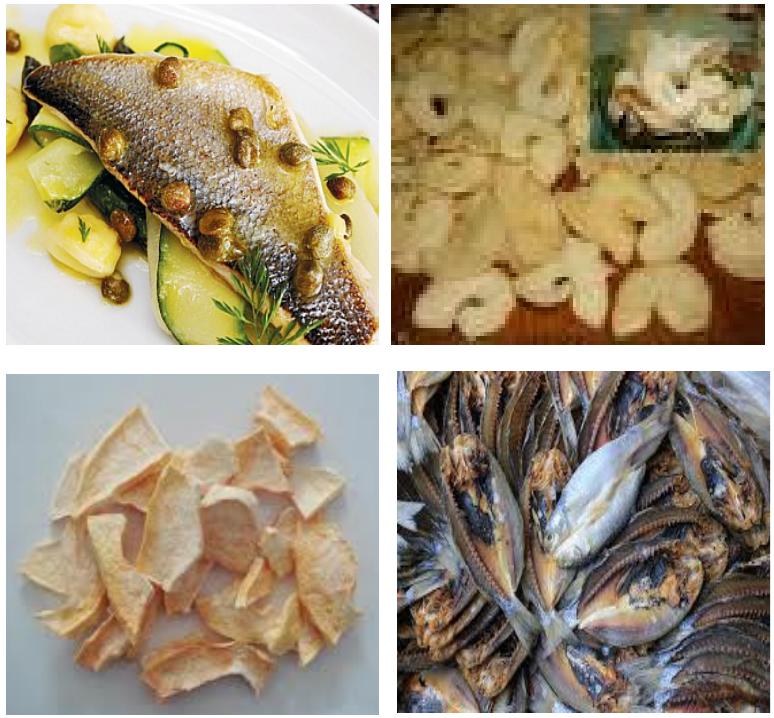
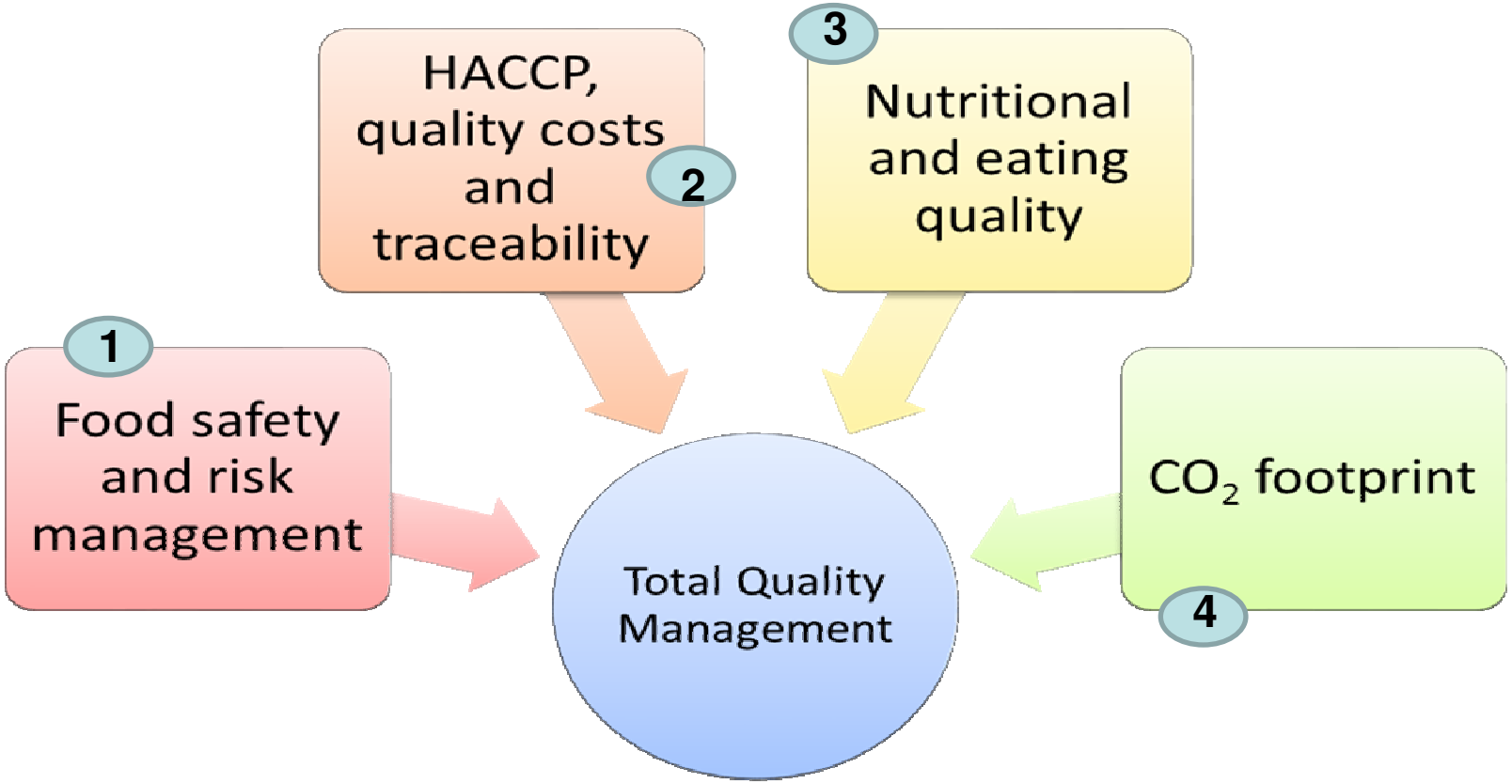
WP4 - OBJECTIVES

DEVELOPMENT OF QUALITY CONTROL MANAGEMENT TOOLS AND GUIDELINES

- To develop a food safety and risk assessment tool
- To assess HACCP, quality costs and traceability
- To investigate nutritional and eating quality of the products
- To undertake carbon footprint analyses
- To develop guidelines for Total Quality Management



WP4 - OBJECTIVES



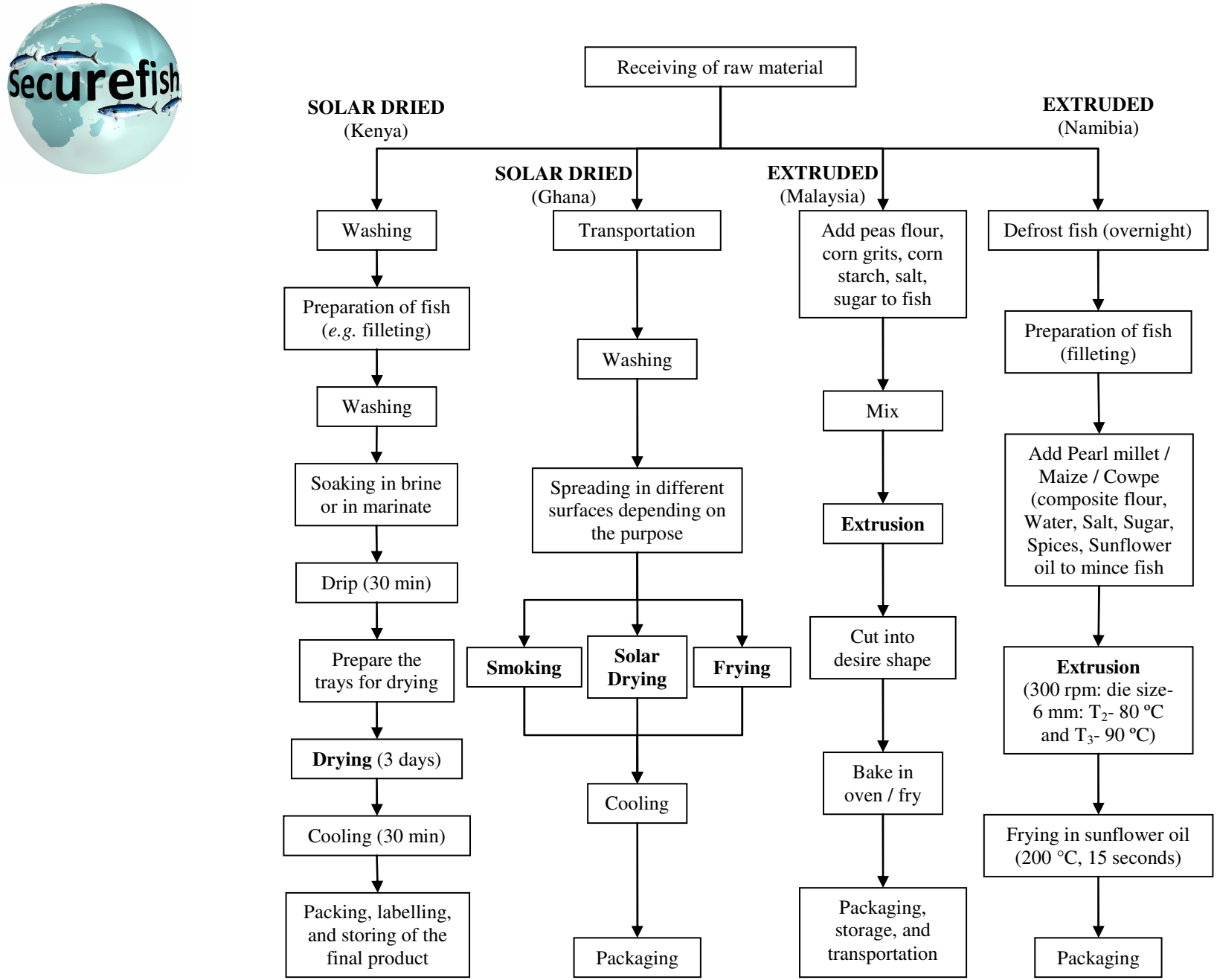
WP 4 - FOOD SAFETY AND RISK ASSESSMENT TOOL

It is known, that seafood has:

- **Balanced amino acid profile**
- **High PUFA - ω3 fatty acids content**
- **Significant amounts of essential minerals**

…and may present some hazards:

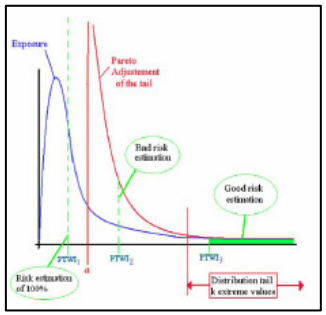
- **Toxic metals (Hg, Pb, Cd, etc.)**
- **Microrganisms (Bacteria, Virus, etc.)**
- **Organic contaminants (PCBs, etc.)**
- **Marine biotoxins**
- **…**


Receiving of raw material
SOLAR DRIED
(Kenya)
SOLAR DRIED
(Ghana)
EXTRUDED
(Malaysia)
EXTRUDED
(Namibia)
Washing
Preparation of fish (e.g. filleting)
Washing
Soaking in brine or in marinate
Drip (30 min)
Prepare the trays for drying
Drying (3 days)
Cooling (30 min)
Packing, labelling, and storing of the final product
Transportation
Washing
Spreading in different surfaces depending on the purpose
Smoking
Solar Drying
Frying
Cooling
Packaging
Add peas flour, corn grits, corn starch, salt, sugar to fish
Mix
Extrusion
Cut into desire shape
Bake in oven / fry
Packaging, storage, and transportation
Defrost fish (overnight)
Preparation of fish (filleting)
Add Pearl millet / Maize / Cowpe (composite flour, Water, Salt, Sugar, Spices, Sunflower oil to mince fish
Extrusion
(300 rpm: die size- 6 mm: T2- 80 ºC and T3- 90 ºC)
Frying in sunflower oil (200 °C, 15 seconds)
Packaging

WP 4 - FOOD SAFETY AND RISK ASSESSMENT TOOL

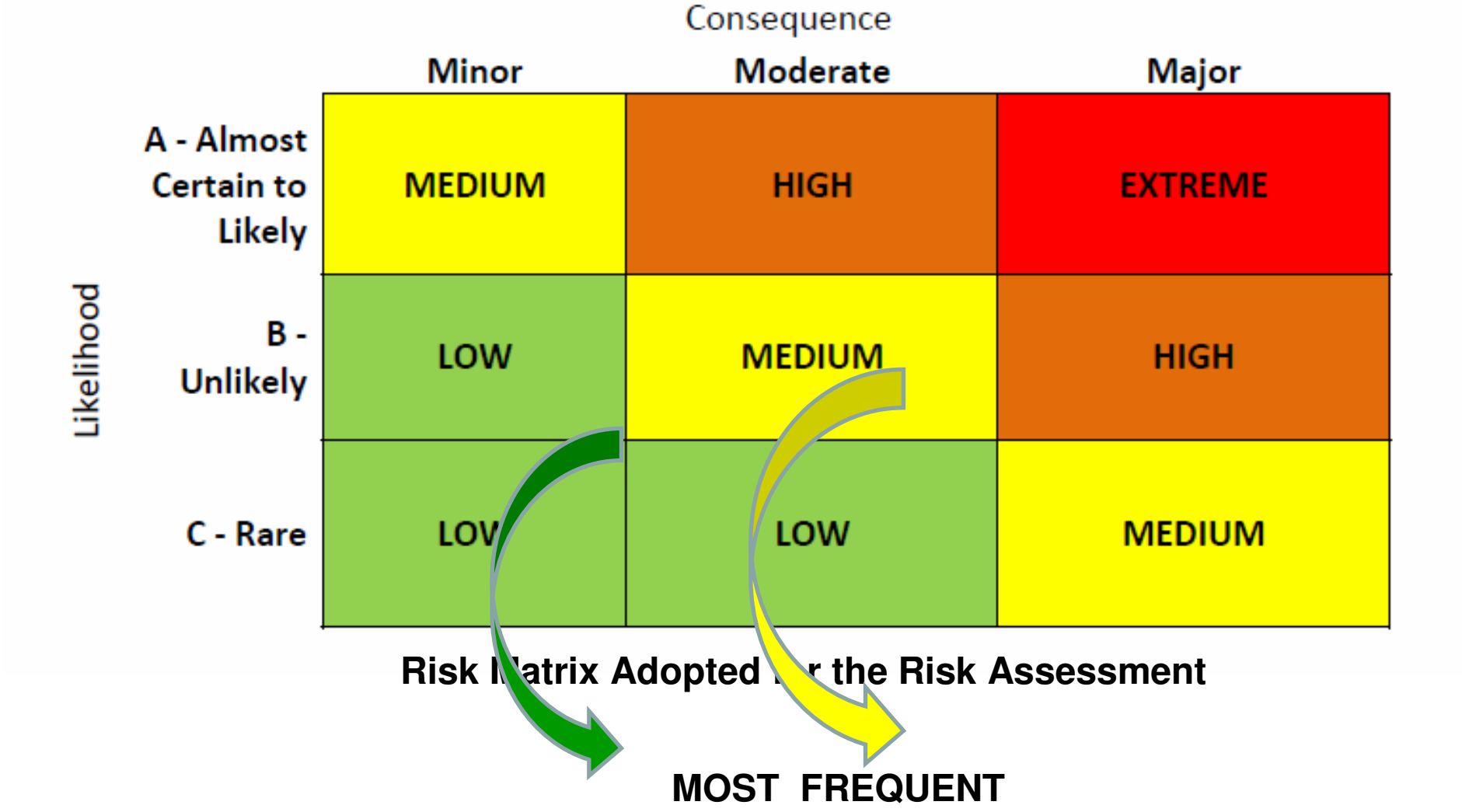
How to assess the risks and benefits associated to the consumption of seafood?

- Identify main risks and benefits
- Apply a probabilistic approach
- Quantify probability of exceeding thresholds
- Balance probabilities of exposure to hazards and attainment of benefits



WP 4 - FOOD SAFETY AND RISK ASSESSMENT TOOL

Identify main risks and benefits



WP 4 - FOOD SAFETY AND RISK ASSESSMENT TOOL

Supply chain	Risk	Fresh/frozen fish	Dried fish	Extruded fish	CAFD fish
		Current risk assessment (with existing controls)			
	Bacterial / viral contamination (Hystamine ??)	LOW Depends on species	LOW Depends on species	LOW Depends on species	LOW Depends on species
Pre-harvest	Contamination by accumulation of heavy metals	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Contamination by agricultural and industrial chemicals	LOW	LOW	LOW	LOW
Harvesting	Contamination from workers, machinery or water sources	LOW	LOW	LOW	LOW
Processing	Microbiological contamination of products, food-packaging materials, and food-contact surfaces from employees	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Microbiological contamination from environmental sources (premises and equipment)	MEDIUM	MEDIUM	MEDIUM	MEDIUM

WP 4 - FOOD SAFETY AND RISK ASSESSMENT TOOL

Supply chain	Risk	Fresh/frozen fish	Dried fish	Extruded fish	CAFD fish
		Current risk assessment (with existing controls)			
Storage and packaging	Microbiological contamination and growth during storage and packaging	LOW	LOW	LOW	LOW
Transport	Microbiological contamination and growth during transport	LOW	LOW	LOW	LOW
Wholesale	Microbiological contamination and growth during wholesale	LOW	LOW	LOW	LOW
Retail	Microbiological contamination and growth during retailing	MEDIUM	MEDIUM	LOW/ MEDIUM	LOW
	CATEGORIES	Cooked	Cooked	As an ingredient Cooked	Cooked

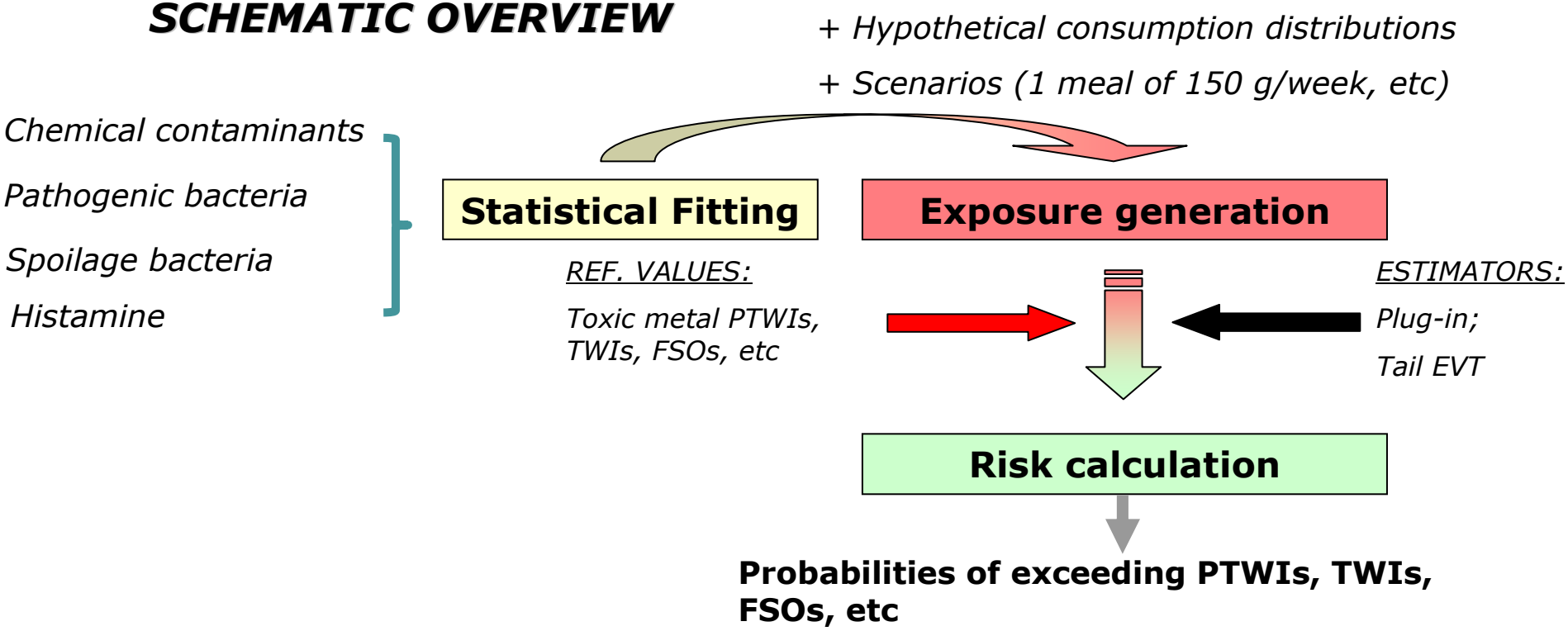
Apply a probabilistic approach

- **Sampling methods – Hypercubic *vs* Monte Carlo random sampling (@RISK or Crystalball)**
- **Probability estimators – Plug-In *vs* Extreme Value Theory**
- **Risk-benefit comparison methodologies – Direct probabilist *vs* QALYs *vs* DALYs**

Chosen tools for the WP4 of SECUREFISH

IN CONCLUSION

SCHEMATIC OVERVIEW



PTWI - The provisional tolerable weekly intake by kg of body weight
TWI – Tolerable weekly intake by kg of body weight
FSOs – Food safety objectives

WP 4-Microbiological and chemical safety

An update of microbiological and chemical methods was supplied.

1. Methods for validation of microbiological quality of seafood

Main microbiological analyses used as indicator :

1. **Mesophilic aerobic plate count**
2. **Hydrogen sulfide (H_2S)-producing bacteria**
3. **Enterobacteriacea**
4. **Molds and yeasts**
5. **Lactic bacteria (sometimes used)**
6. **Psychrotrophic aerobes (sometimes used)**

Main microbiological analyses for testing hygiene and handling :

1. **Coliforms**
2. ***Enterococci***
3. ***Staphylococcus aureus***

WP 4-Microbiological and chemical safety

2. Methods for chemical safety

Main seafood contaminants used :

1. **Mercury**
2. **Cadmium**
3. **Lead**

Main indicators of degradation :

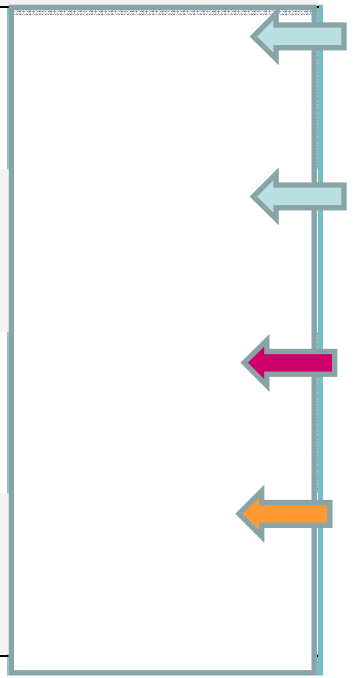
1. **Total Volatile Base Nitrogen (TVB-N) and Trimethylamine (TMA-N)**
2. **Peroxide value (PV)**
3. **Malondialdehyde (MDA)**

WP 4 - FOOD SAFETY AND RISK ASSESSMENT TOOL

EXAMPLE

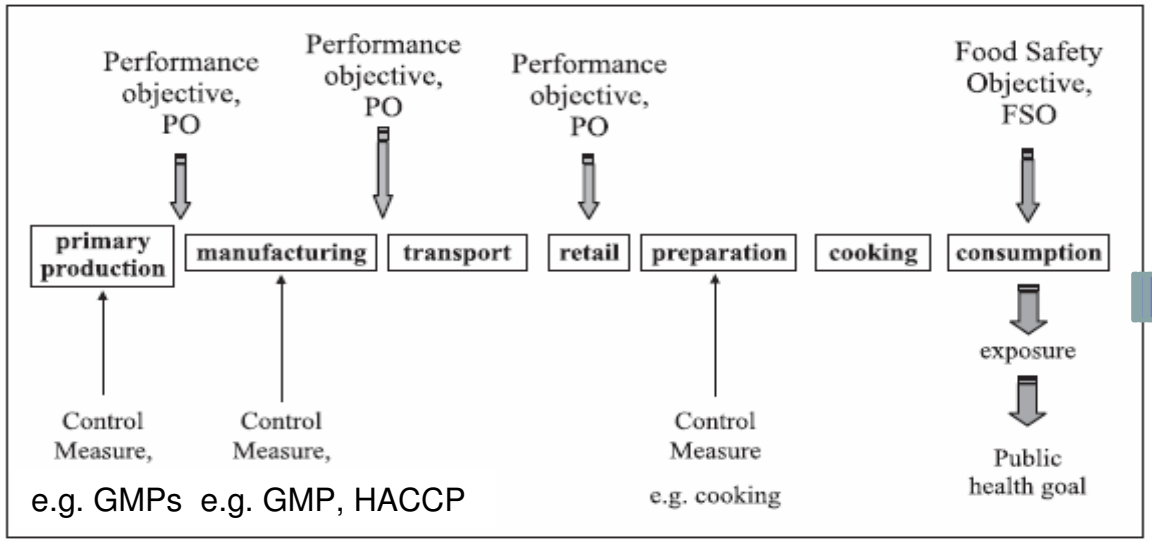
Probability of Exceeding the MeHg PTWI and EPA+DHA and Se DRI, P(Xi > PTWI or DRI) (%), in different species.

		$P(X_i > PTWI \text{ or } DRI)$ (%)		
		1 Meal/ Week	2 Meals/ Week	3 Meals/ Week
Fish 1	MeHg (PTWI)	$<1.0x10^{-8}$	$1.8x10^{-5}$	
	Se	$2.6x10^{-2}$	0.12	
	EPA+DHA	$<1.0x10^{-8}$	$<1.0x10^{-8}$	
Fish 2	MeHg (PTWI)	$<1.0x10^{-8}$	$9.2x10^{-7}$	
	Se	$2.3x10^{-8}$	$1.5x10^{-4}$	
	EPA+DHA	$<1.0x10^{-8}$	$9.8x10^{-4}$	
Fish 3	MeHg (PTWI)	$<1.0x10^{-8}$	$2.9x10^{-3}$	
	Se	$<1.0x10^{-8}$	$4.1x10^{-5}$	
	EPA+DHA	$1.9x10^{-7}$	0.11	
Fish 4	MeHg (PTWI)	$3.0x10^{-5}$	0.17	
	Se	$4.6x10^{-6}$	$7.5x10^{-4}$	
	EPA+DHA	$1.2x10^{-4}$	0.10	



Consumptions up to two meals of 160 g/week are recommended (PTWI).

WP 4 - FOOD SAFETY AND RISK ASSESSMENT TOOL



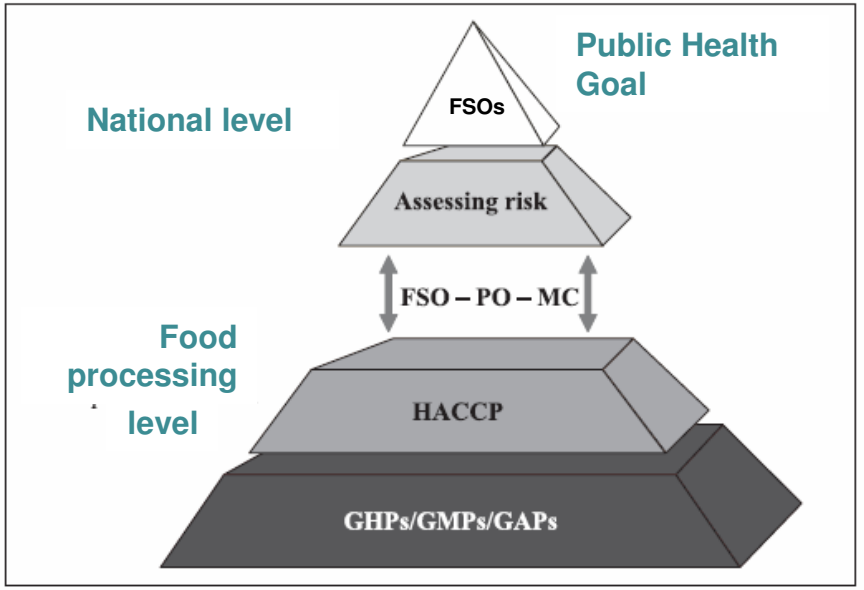
Requirements:

- *Process knowledge*
- *Process criteria (T,t)*
- *Product criteria (a_w, pH)*
- *Initial microbial loads*
- *MC, FSOs, POs*
- *GMPs, GHPs*
- *HACCP*

MC - Microbiological criteria
FSOs - Food Safety Objectives
POs - Performance Objectives
FSOs and POs are distinct levels of foodborne hazards.

FSOs cannot be exceeded at the point of consumption and POs cannot be exceeded earlier in the food chain.

The good practices- GMPs and GHPs- and Hazard Analysis Critical Control Point (HACCP) are the tools for achieving an FSO or PO



MICROBIAL SAFETY

Due to:

- **intrinsic characteristics of the developed products [low a_w (≤ 0.3) and pH (5.5-7.0)]**
- **The intended use is as an ingredient and cooked before consumption)**

…no microbiological limits were defined

The main hazard is related to the histamine formation in some species, which is thermostable and should be controlled in the raw material (limit: 100 ppm/kg)

CHEMICAL SAFETY

Me-Hg
PTWI- 1,6 mg/kg bw/week
TWI - 1,3 mg/kg bw/week

Pb
PTWI - 25 mg/kg bw/week

Cd
PTMI - 25 mg/kg bw/week
TWI - 2,5 mg/kg bw/week

WP 4-Microbiological and chemical safety

Hazard Analysis Critical Control Points

PRINCIPLES

1. Conduct hazard analysis
2. Determine critical control points (CCPs)
3. Establish critical limits
4. Establish system to monitor CCPs
5. Develop response when CCP violated
6. Verify that HACCP system is working
7. Document all HACCP procedures

OBJECTIVES

1. Legal requirement
2. Useful commercial business tool
3. Improves quality of product
4. Ensures safety of products
5. Provides competitive advantage
6. Minimizes economic risks
7. Internationally recognized

WP 4-Microbiological and chemical safety

Hazard Analysis Critical Control Points

Benefits of HACCP

1. Reduction or elimination of food safety hazards
2. Represents a preventative method
3. Recognition and thus control
4. Less end product quality tests
5. Marketing tool
6. Improved supplier status
7. Documentation = protection

What does HACCP do?

- Prevents food safety hazards at all steps during production and processing
- Places industry in position of responsibility for food safety
- Industry thereby in hot seat for public health

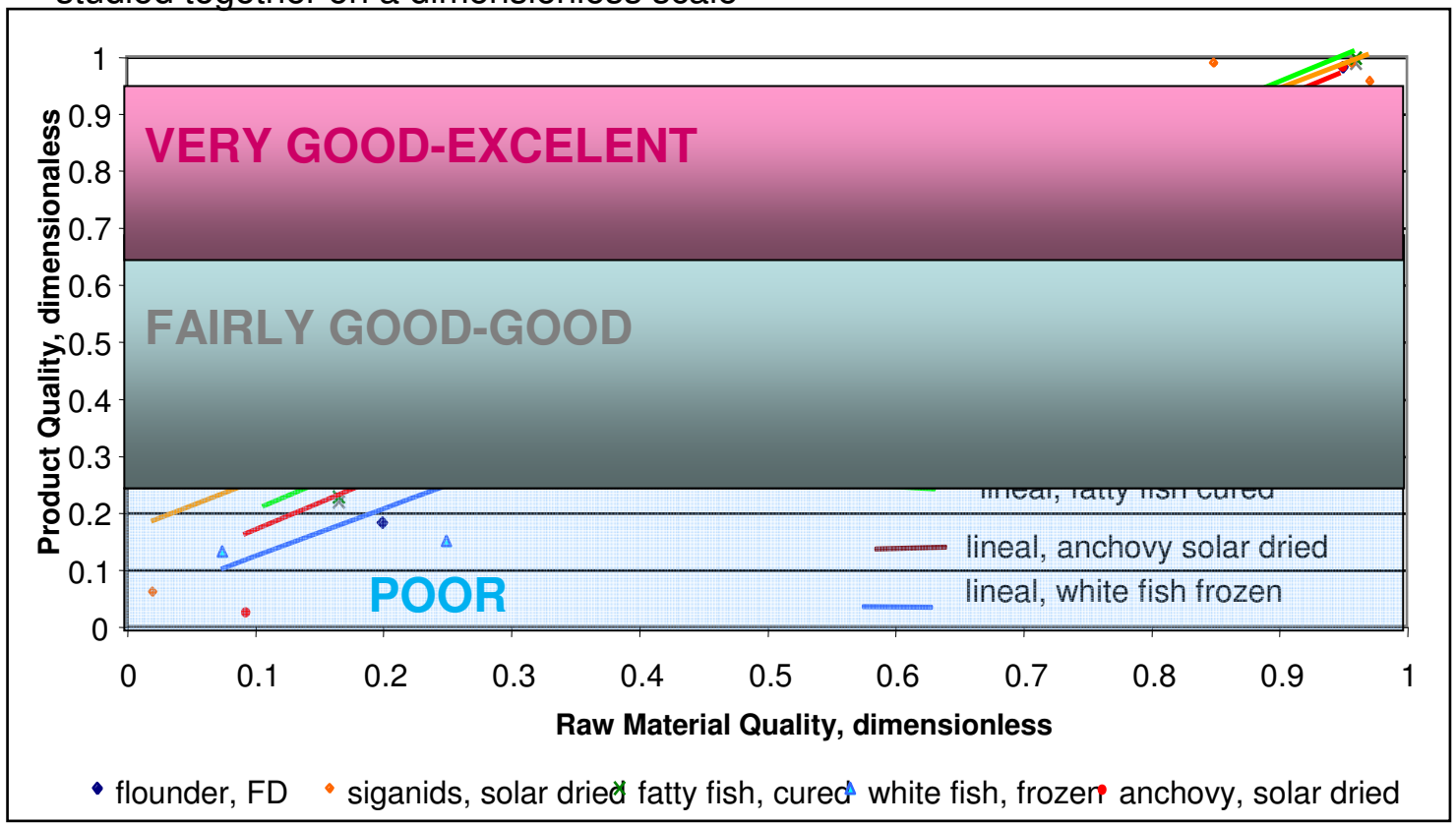
QUALITY COSTS

Used species:

- Flounder (*Paralichthys patagonicus*), freeze dried (INTI, Argentina)
- Siganids (*Siganus sutor*), solar dried (Odour *et al*., Kenya)
- Anchovy (*Stolephorus sp.*), solar dried (Shamasundar *et al*., India)

WP 4 Quality Costs

Physical, biological, chemical, microbiological, and sensory quality characteristics of raw material and final products (proximate composition, pH, TVBN, TMA, PV, TBA, FFA, TPC, raw organoleptic assessment), studied together on a dimensionless scale



All the results indicated that the final quality of any processed product is most strongly influenced by the initial quality of the fish.

- Good raw material quality also increased the yield and productivity.
- For flounder, skin-on filleting yield was analyzed. A linear relationship between

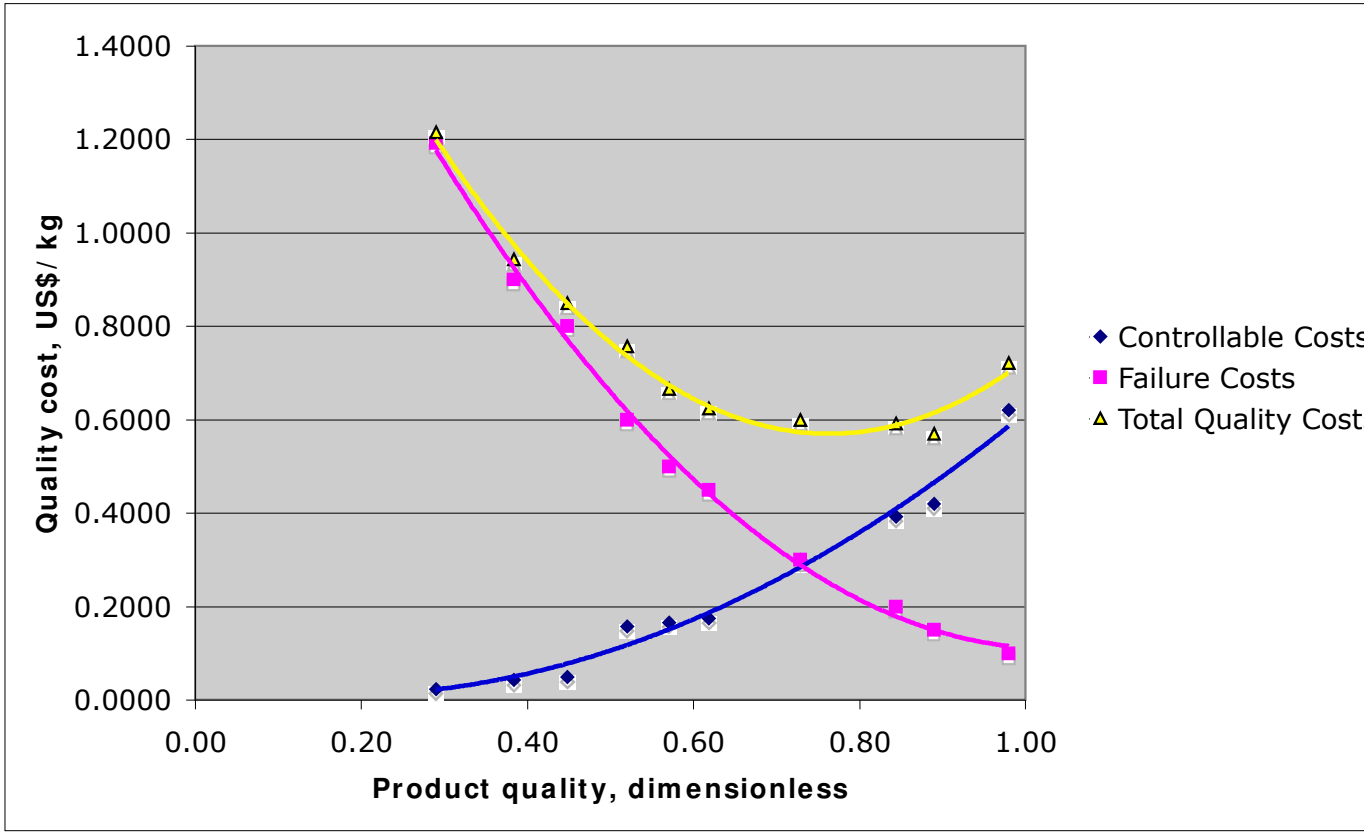
WP 4 Quality Costs

A quality cost model for food processing plants has been developed and published (Zugarramurdi *et al*., 2007).

Quality costs for Solar dried fish

Regression analysis of the controllable costs (CC), failure costs (FC), and total quality costs (TQC) per unit of product for different levels of quality resulting from the application of the proposed model.

Regression equations for the model were obtained fitting polynomial curves to the model values



NUTRITIONAL ASPECTS and EATING QUALITY

NUTRITION FACTS
Serving size: 160 g
Farmed salmon, Raw

Amount per serving		
Energy: 409 kcal **Energy from Fat**: 287 kcal		
		% Daily value
Total Fat	**31.8 g**	50
SAT Fat	5.3 g	30
MUFA	14.6 g	
PUFA	9.4 g	
n-3 PUFA	5.6 g	
n3/n6	1.6	
Sodium	**377 mg**	16
Carbohydrate	0 g	
Protein	30.6 g	61
Calcium	150 mg	
Selenium	35 µg	

EATING QUALITY FACTS

Sensory attribute	Scale (0-100)	Definition
Odor		
Corn snack	None | Much	Regular corn snack's odor
Rancid	None | Much	Rancidity odor
Shrimp	None | Much	Shrimp odor
Frying	None | Much	Odor of fat from frying
Appearance		
Color (external)	Little | Much	Orange-reddish color at surface of snacks
Color (internal)	Light | Dark	Inside the snacks: Is the color dark or light?
Texture		
Crispness	Little | Much	Crispness of snack after first biting
Softness	Firm | Soft	Softness of snacks when chewed and rubbed against palate with tongue.
Flavor		
Corn snack	None | Much	Regular corn snack's flavor
Shrimp	None | Much	Shrimp flavor
Rancid	None | Much	Rancidity flavor
Frying	None | Much	Flavor of fat from frying
Bitterness	None | Much	Bitterness of snack after chewing and tasting
Sweetness	None | Much	Sweetness of snack after chewing and tasting
Saltiness	None | Much	Saltiness of snack after chewing and tasting

Handbook was prepared with validated methodologies for the calculation of nutritional value and eating quality

WP 4-Seafood Carbon footprint

Description of your supply chain	
	Enter your data
Please provide a name for the chain you wish to model:	

Fishing / Harvesting Method	
Choose the fishing technique and target which most closely represents those used in your chain:	----
Yield of landed to live weight Value between 1% and 100%:	% (e.g. after gutting at sea)
Yield of final processed form to landed weight Value between 1% and 100%:	%
Are the co-products from processing used in any other product?	○ Yes ◉ No

http://www.seafish.org/GHGEmissionsProfiler/v1/

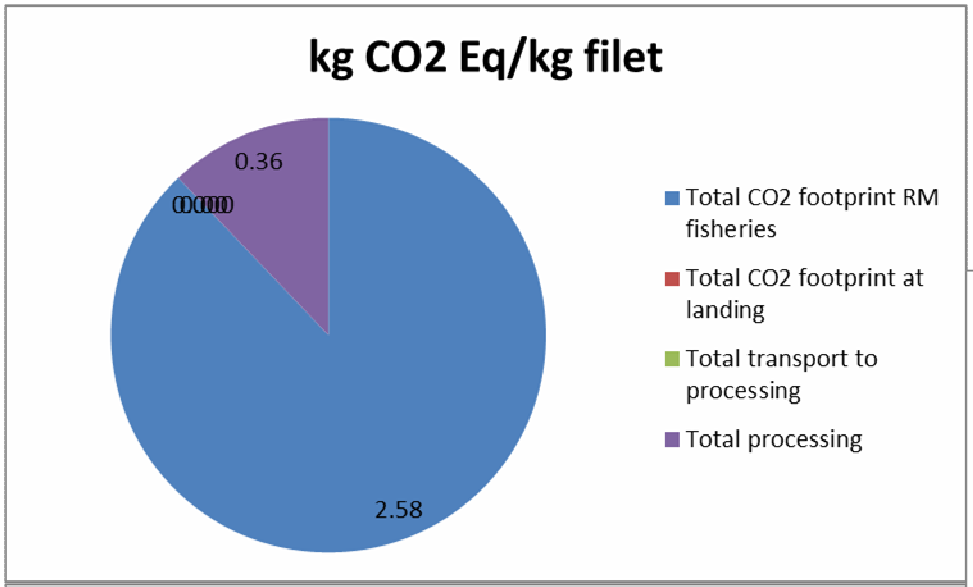
Transport	
Which length unit are you using ?	◉ Km ○ Miles
How far does your product travel pre-processing by:	
Long Haul Flight (over 4 hours)	Km
Short Haul Flight (under 4 hours)	Km
Truck transport	Km
Select type of truck	○ Delivery Van (3.6 tonne) ○ Lorry (16 tonne) ○ Tractor Trailer units
Ship	Km
How far does your product travel post-processing by:	
Long Haul Flight (over 4 hours)	Km
Short Haul Flight (under 4 hours)	Km
Truck transport	Km
Select type of truck	○ Delivery Van (3.6 tonne) ○ Lorry (16 tonne) ○ Tractor Trailer units
Ship	Km

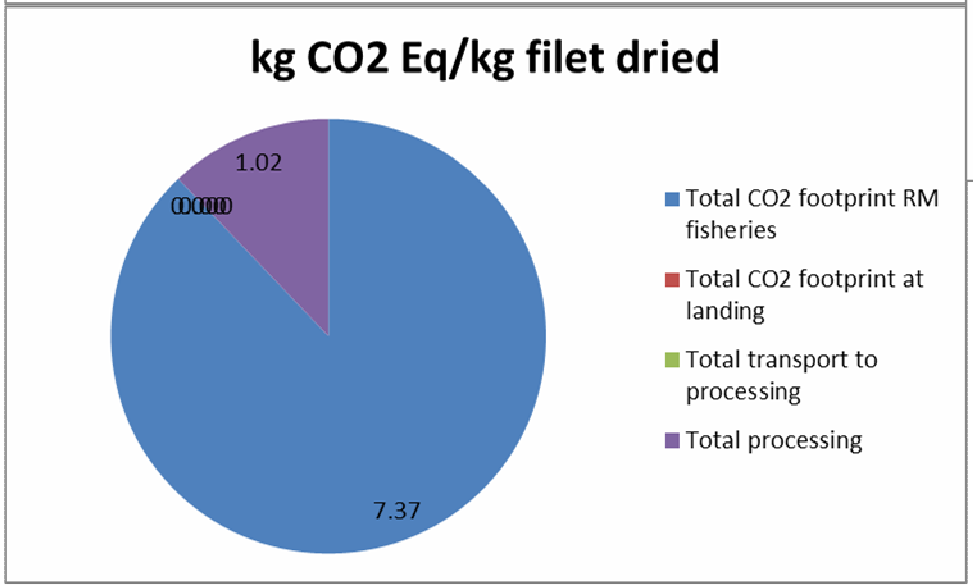
WP 4-Seafood Carbon footprint

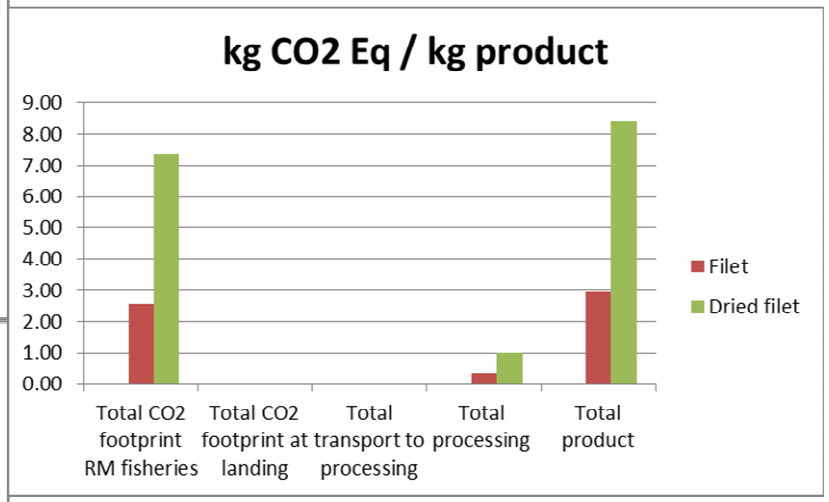
Pre-processing refrigeration	
Was the fish frozen upon landing prior to be transported to processing?	○ Yes ◉ No
Total days refrigerated on fishing boat:	[ ] days
Duration of outbound refrigerated container transport:	[ ] days
Duration refrigerated storage pre processing:	[ ] days
Post-processing refrigeration	
Was the product frozen after processing?	○ Yes ◉ No
Duration refrigerated storage post processing:	[ ] days
Duration of inbound refrigerated container transport:	[ ] days
Duration of refrigerated tractor trailer truck transport:	[ ] days
Duration of refrigerated delivery van transport:	[ ] days
Duration of final product refrigerated storage:	[ ] days

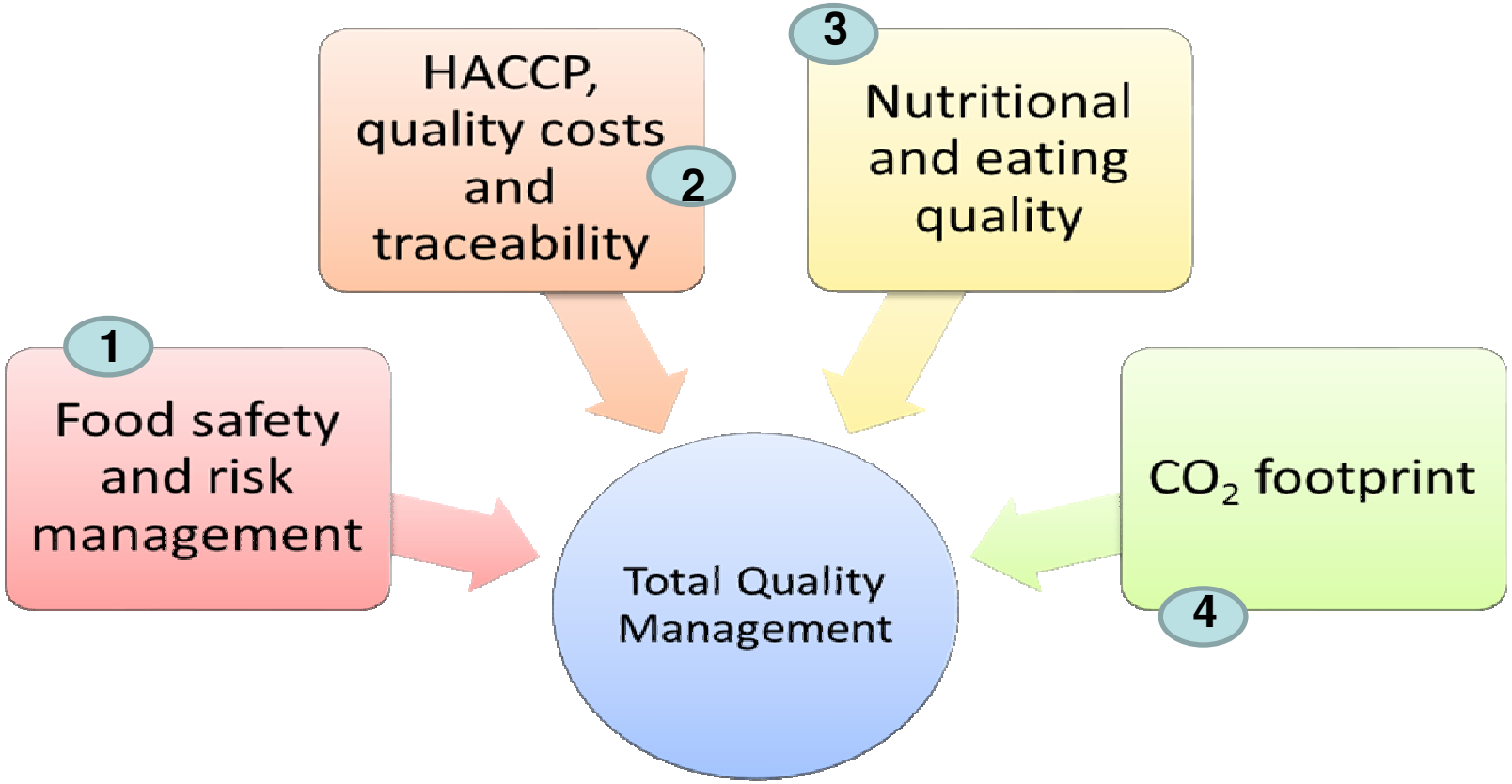
Calculate

WP 4- CO2 footprint CAFD

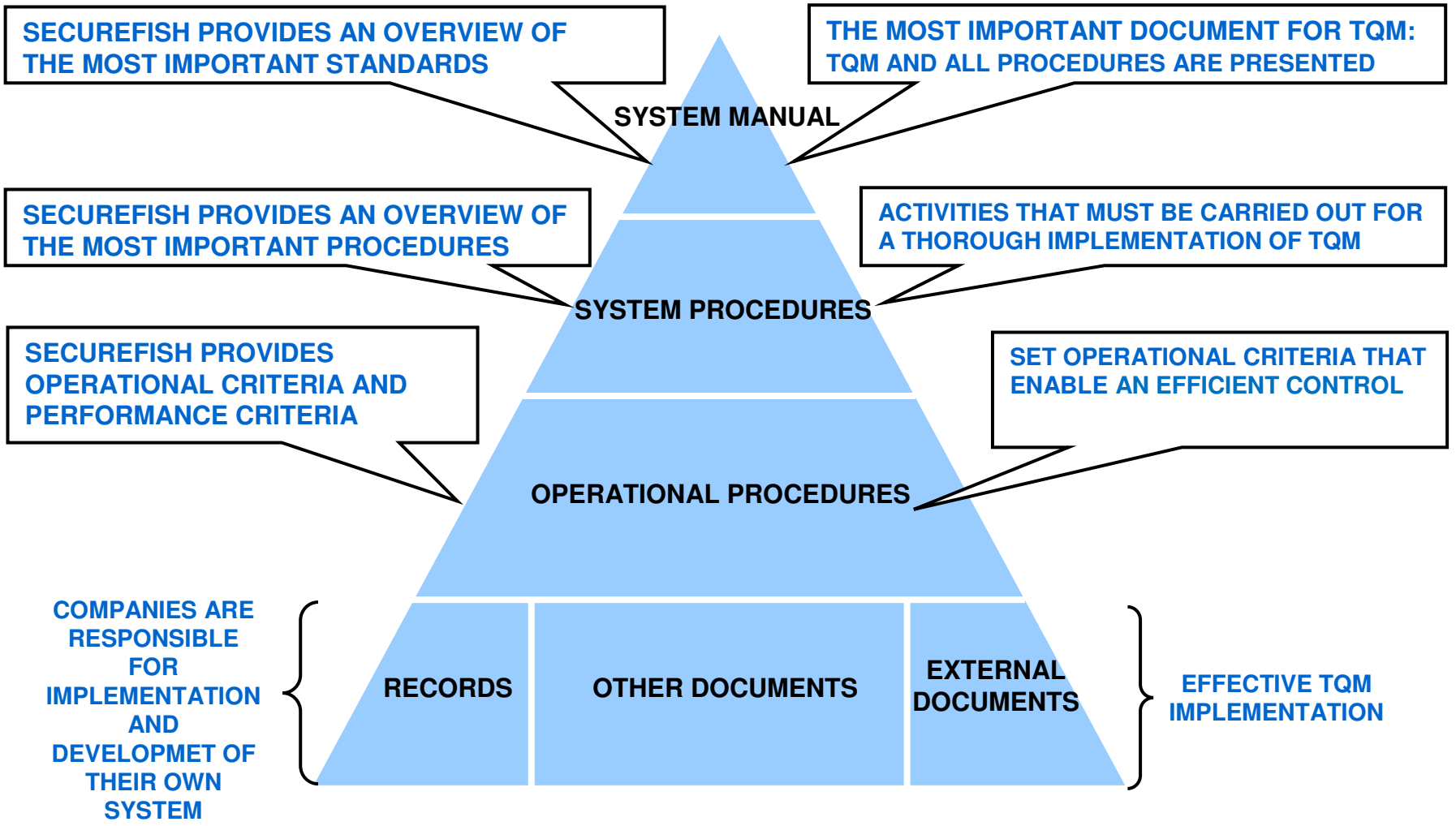







HACCP, quality costs and traceability
2
3
Nutritional and eating quality
1
Food safety and risk management
Total Quality Management
CO_2 footprint
4

The multi-layers in a TQM company



Legal demands are basic

		EU	Export	Urban	Local
Management	*Quality Management / ISO 9001:2008*				
Food Safety	*HACCP / ISO 22000*				
Food Safety	*Traceability / ISO 22000*				
Social	*Social Responsibility / ISO 26000*				
Consumer	*Labelling / Nutritional Values*				
Consumer	*Labelling . Nutritional Values EU*				
Environment	*Environmental Management / ISO 4001*				
Environment	*Simplification of ISO 14001: CO2 footprint*				
Social	*Health and Safety / ISO 14001*				
Environment	*Sustainable sourcing (private labelling)*				

Optional

Mandatory

Thanks for your attention