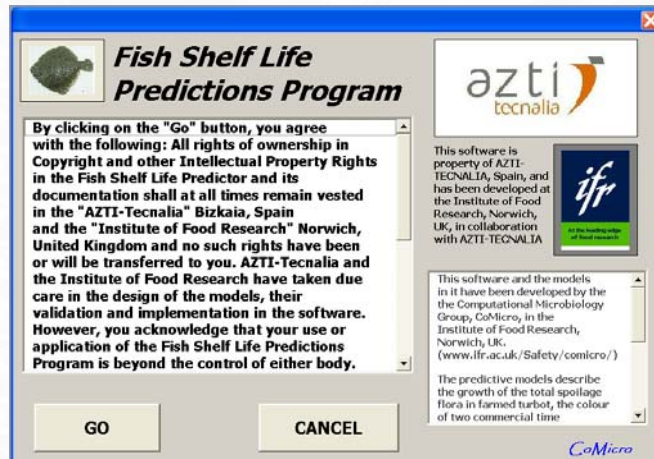


Application of “Fish Shelf life Prediction (FSLP)” software for monitoring seafood quality in the cold chain



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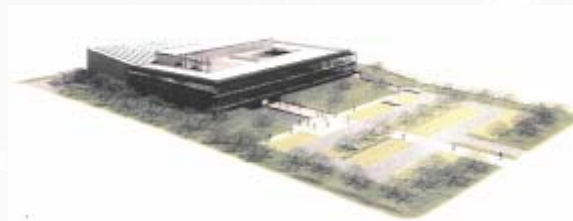
3rd International Workshop “Cold-Chain-Management”
June 2, 2008 in Bonn, Germany



AZTI-Tecnalia, a Technological Centre specialised in Marine and Food Research, is a private non-profit



Pasaia
(Gipuzkoa)

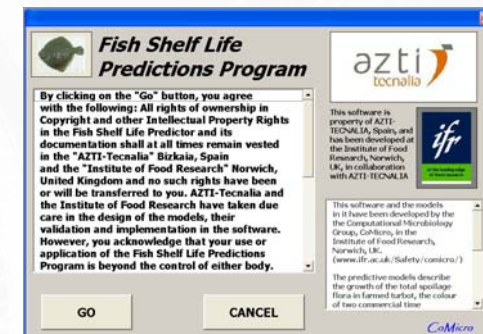


Derio · 2008
(Bizkaia)



➤ **“Fish Shelf Life Prediction Program”** A tool for prediction the shelf life of aquaculture products.

- Introduction
- Objectives of project
- Our research: Materials and methods
- Results: Software “Fish Shelf Life Prediction Software FSLP”
- Real Life implementation
- Conclusions
- Plans for the future



➤ **GOODFOOD European project- Demonstration project**

- Introduction
- Objectives of project
- Results and conclusions



Fresh fish are highly perishable products that deteriorate rapidly if not handled and stored properly

SHELF LIFE IN SEAFOOD PRODUCTS IS A FUNCTION of several factors that influence the spoilage of fish:

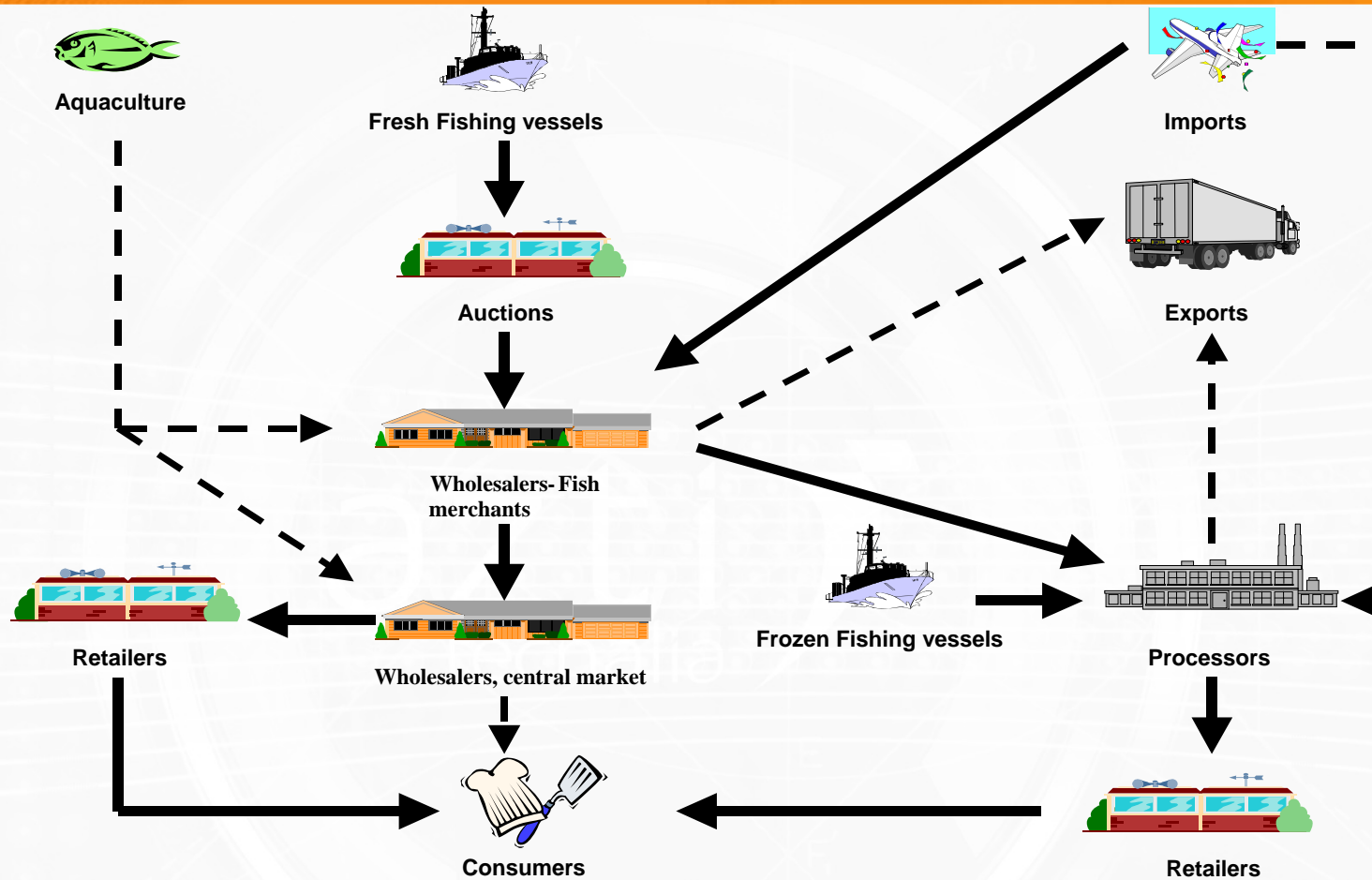
- **Species**
- **Seasonal condition**
- **Catching methods**
- **Handling**
- **Processing**
- **Storage conditions (Time/Temperature)**



- **Spoilage in fish products is mainly due to the action of bacteria**
- **Sensory evaluation:** is one of the most important methods for freshness and quality evaluation in the fish sector and the fish inspection services (Luten and Martinsdóttir 1997)
 - **physical changes**
 - colour, texture change
 - **chemical changes**
 - rancidity, colour change
 - **microbiological changes**
 - visible growth
 - slime
 - textural changes
 - off-odours and off-flavours



Fish Distribution Chain



Safety and Quality Assessment
Time, temperature and traceability information

Objectives of the project



- **Objectives:**

- Develop **kinetic models** to predict the microbial spoilage and the sensory quality of fresh turbot at constant and fluctuating temperature conditions
- Evaluate the efficiency of a commercial **time temperature integrators (TTI)** label to monitor the fresh turbot shelf-life
- Develop a user-friendly **software able to predict the shelf life of farmed fresh fish** according to the microbial growth but also to the sensory evaluation

- **Materials- Fish**
- **Turbot (*Psetta maxima* or *Scophthalmus maximus*)**
- **Fish were chilled in ice, transferred to the lab within 1,5 hours**
- **Samples were packaged in extended PVC film individually**



obtained directly from aquaculture



- **Methods:**

- **Preservation studies were carried out under normal and abusive conditions:**

- 0 , 5 , 10 and 15 °C.
- Two dynamic storage experiments: non-isothermal



- **Microbiological measurements:**

- Total aerobic viable counts (TVC)
- Enterobacteriaceae
- SSO (specific spoilage organisms: *Pseudomonas* spp.
- *Shewanella putrefaciens*, *B. thermosphacta*

- **Sensory evaluation** by trained panel (ISO 1993):

- Cooked fish : odour, flavour and texture
- Raw fish: Using a 6 point descriptive scale (ISO 41:21:1987)



- Definition of time-temperature indicators TTI:

A simple, inexpensive device that shows an easily measurable, time-temperature dependent change that reflects the full or partial temperature history and quality status of the food product to which it is attached to. (Taoukis and Labuza, 1989)

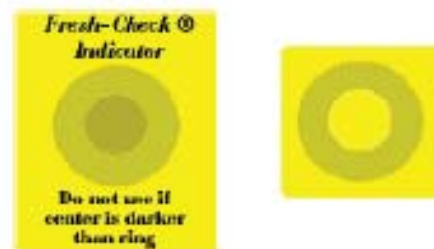
Monitor Mark (3M)



Check Point® (Vitsab)



Fresh Check® (LLT)



➤ Response of TTIs: Colorimeter (Minolta CR-200)

Data generation	Primary Modelling	Secondary modelling	Validation of models
<p>Bacterial growth curves</p> <p>Sensory score</p> <p>Response of TTIs</p>	<p>Models of Baranyi and Robert (1994)</p> <p>PCA (Principal Components Analysis)</p> <p>Rate of change of colour (empirical models)</p>	<p>Model the effect of temperature on bacterial growth sensory assessment and rate of change, of TTIs</p>	<p>Evaluate the performance of the models by comparison predictions with observations</p>



RESULTS: Finding the spoilage rate: Model of Baranyi and Roberts (1994)

Fig 1 Total aerobic flora in turbot. Model (red line)

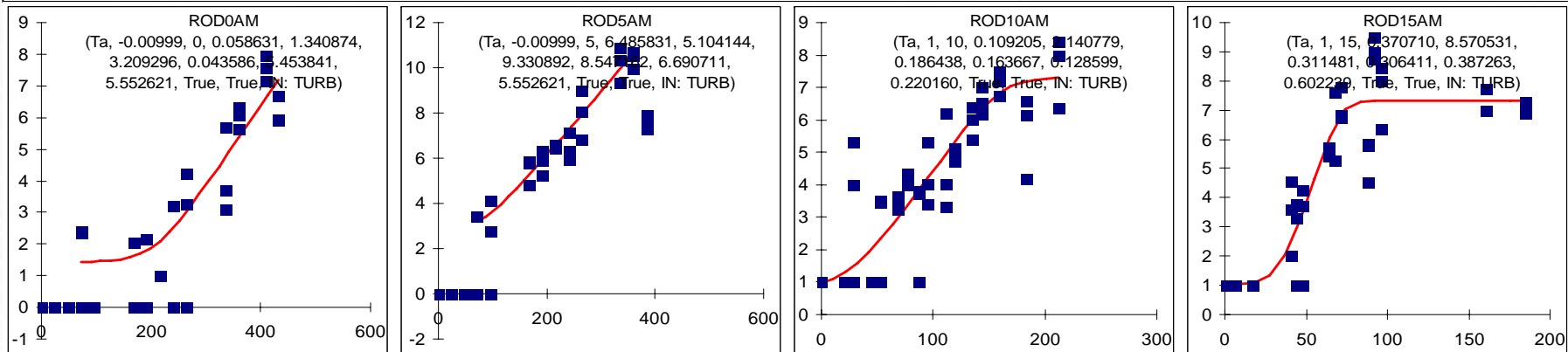
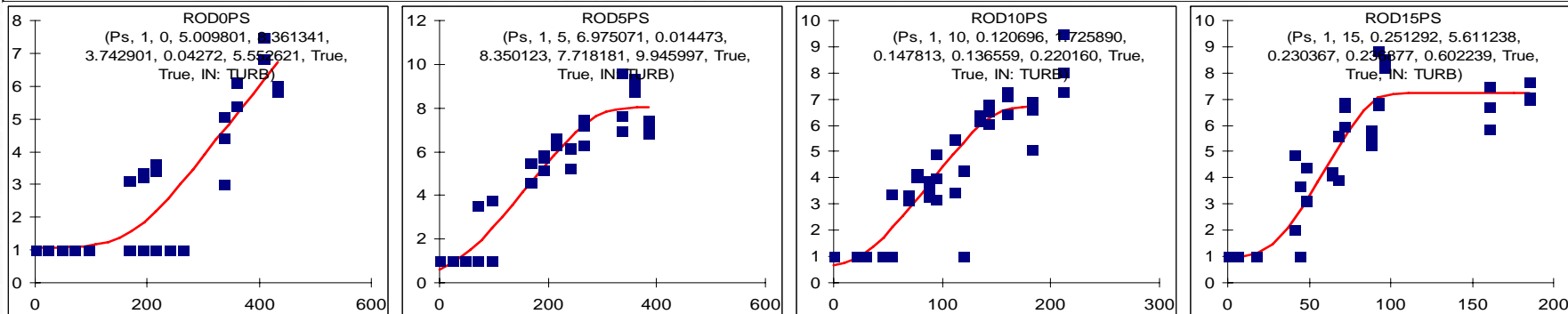


Fig 2 Pseudomonas in turbot. Model (red line)

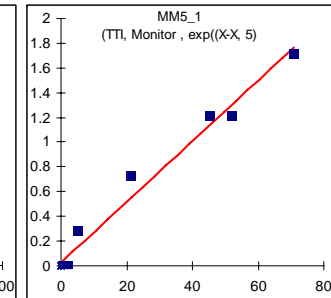
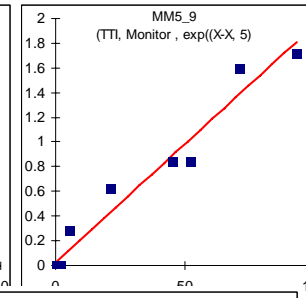
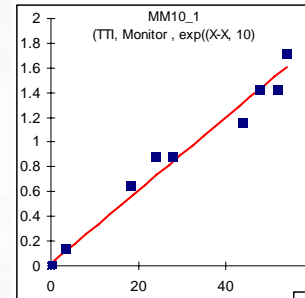


In: Mainer Nuin, Begoña Alfaro, Ziortza Cruz, Nerea Argarate, Susie George, Yvan Le Marc, June Olley and Carmen Pin* **Modelling spoilage of fresh turbot and evaluation of a time-temperature integrator (TTI) label under fluctuating temperature.** Int J Food Microbiol, (in press).

RESULTS: Finding the rate of change of TTIs: Primary models

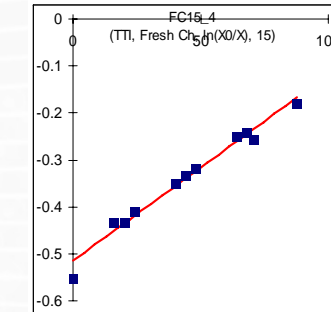
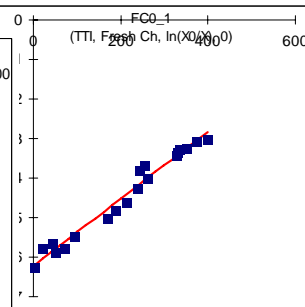
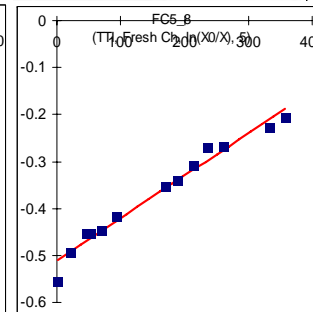
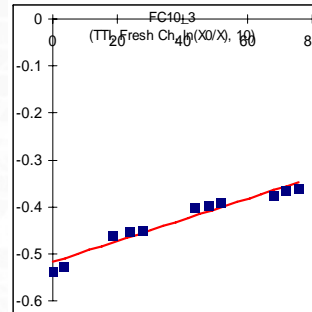
Monitor Mark

$$F(x) = e^{\frac{x-x_0}{x_m-x_0}} - 1$$



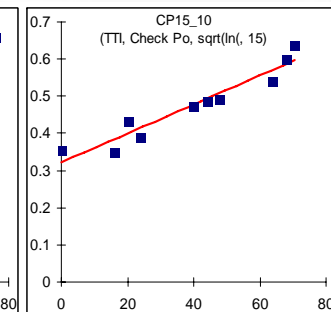
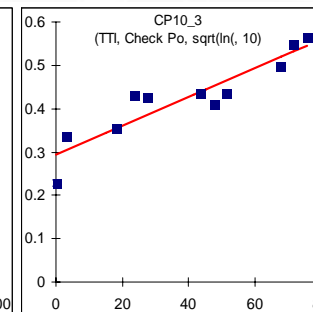
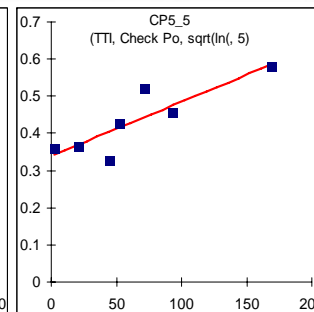
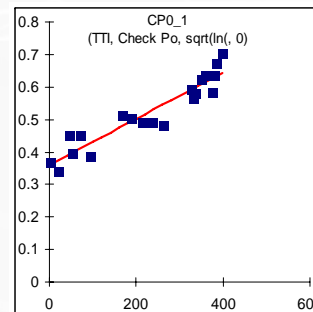
Fresh Check

$$F(x) = \ln\left(\frac{x_0}{x}\right)$$



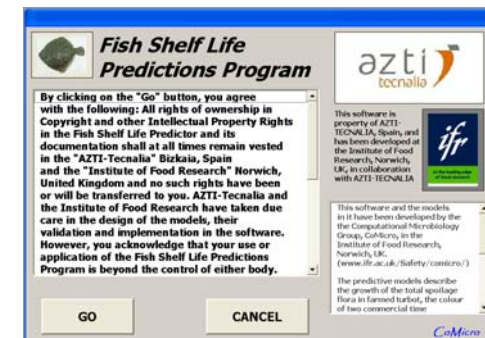
Check Point

$$F(x) = \sqrt{\ln\left(1 + \frac{x-x_0}{x_m-x_0}\right)}$$



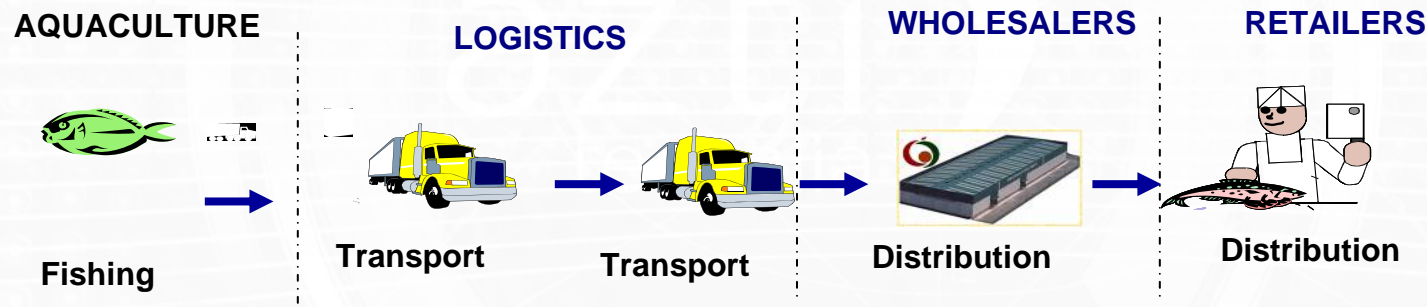
SOFTWARE “FISH SHELF LIFE PREDICITON PROGRAM (FSLP)” (AZTI_Institute of Food Research-UK):

- The models have been implemented in a Visual Basic add-in for Excel “**Fish Shelf Life Prediction (FSLP) program**”
- This program predicts the **shel life of fresh turbot** at contants and fluctuating temperature conditions according:
 - Sensory acceptability: rejection time (hours)
 - Growth of spoilage bacteria (\log_{10} cfu/g) (log
- Response of **two commercial time-temperature integrators** (hours): Monitor Mark ® and Fresh Check®



“Monitoring time/ T^a data for the fresh turbot logistic chain from fish farmed (Spain) to distribution (Italy)”

Implementation of an *online T^a* monitoring system for the fresh fish logistic chain



- To enable a future generation of producers and logistic groups to trace fish at any time.
- To protect consumers from the consumption of unsafe fish.

Fresh Turbot Logistic Chain

The chain starts when the turbot is captured in the fish farmer (San Sebastian-Spain) and transport to Irun (Spain) food perishable centre in refrigerated truck...



Data-loggers were placed inside a polystyrene box with the fish



Fresh Turbot Logistic Chain

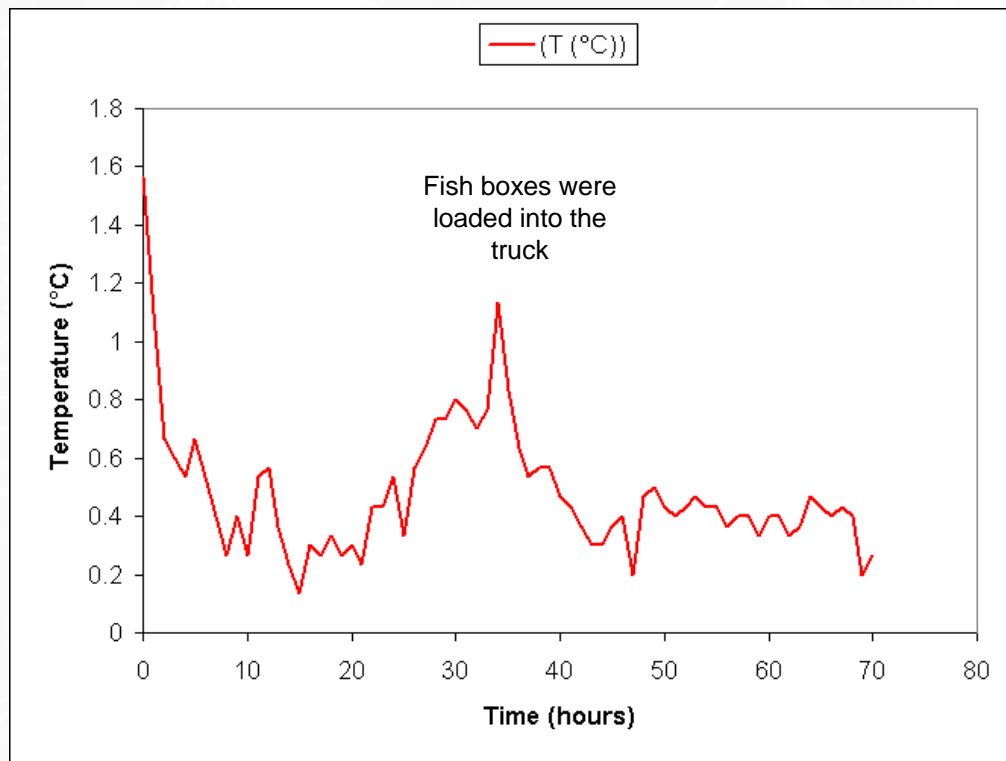
From Irun (Spain) → Zaragoza (Spain) → Barcelona (Spain)
→ Ghioggia(Italy) in refrigerated trucks...



The whole logistic chain can take around 3 days from the capture to the consumer

Results Real life implementation

- Measured by 3 data-loggers → T^a was kept below 2°C along the complete journey of 72 hours
- Correlation of T^a peaks with events along the truck transport



Application of Fish Shelf life Prediction Program for monitoring fresh turbot quality in the cold chain.

Predictions for a given time

Write here time in hours and click "Predict"

Predicted total bacterial load Log₁₀ cfu/g

Predicted sensory score - According to a trained sensory panel. Rejection limit is 6 in a scale from 9 (fresh) to 4 (spoiled)

Predicted colour scores for the TTIs. Rejection limit is below 51.5 for the Fresh Check and over 44 for the Monitor Mark.

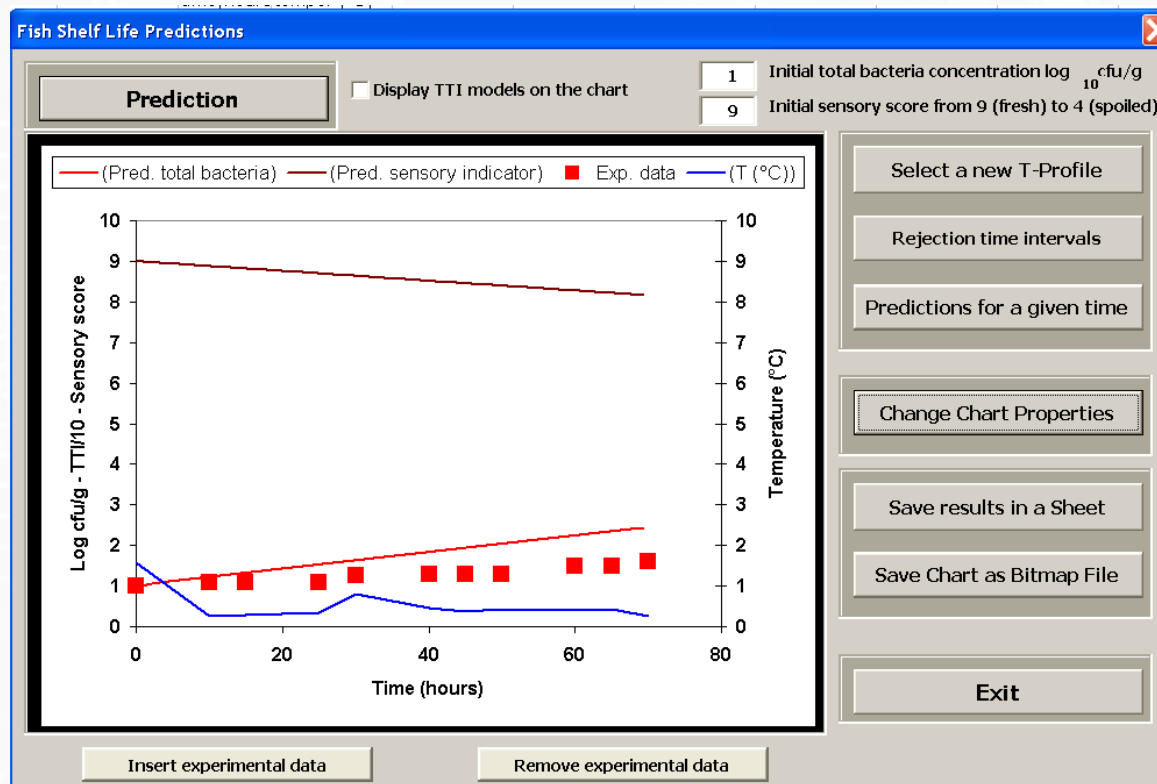
Fresh Check

Monitor Mark

Notice that the total bacteria load and the Monitor Mark scores increase with time while the sensory scores and the Fresh Check scores decrease!

Figure: Screenshot from "Fish Shelf Life Prediction Program (FSLP)" for the fresh turbot transported from Spain to Italy (70 hours) showing the predicted total bacteria and sensory score. In addition, showing the scores for the TTIs.

Comparison of growth of total bacteria: observed and predicted data



CONCLUSIONS

- ✓ **Modelling shelf life and quality on real fresh fish products is difficult but possible**
- ✓ **To predict shelf life it is important to have information about raw materials, to have the time-temperature profiles of the product**
- ✓ **We have developed a software able to predict the shelf life of farmed fish (turbot) products taken into account microbial and sensory parameters (at constant or fluctuating temperatures)**
- ✓ **Prediction softwares: useful tools for cold chain management.**

- Available free version of the software **“Fish Shelf Life Prediction Program FSLP”** in internet for industry, food inspection services, teaching, research and consumer organisations)

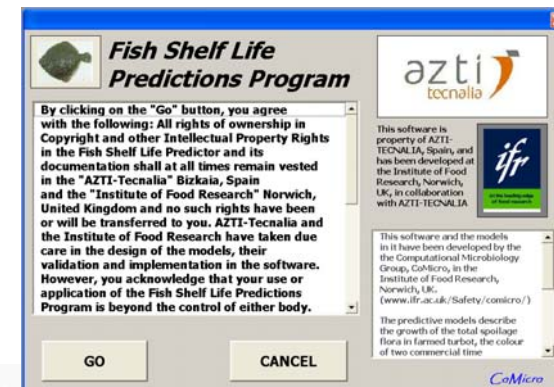
<http://www.azti.es/muestracontenido.asp?idcontenido=980&content=15&nodo1=30&nodo2=0>

(Spanish version)

<http://www.azti.es/muestracontenido.asp?idcontenido=981&content=15&nodo1=30&nodo2=0>

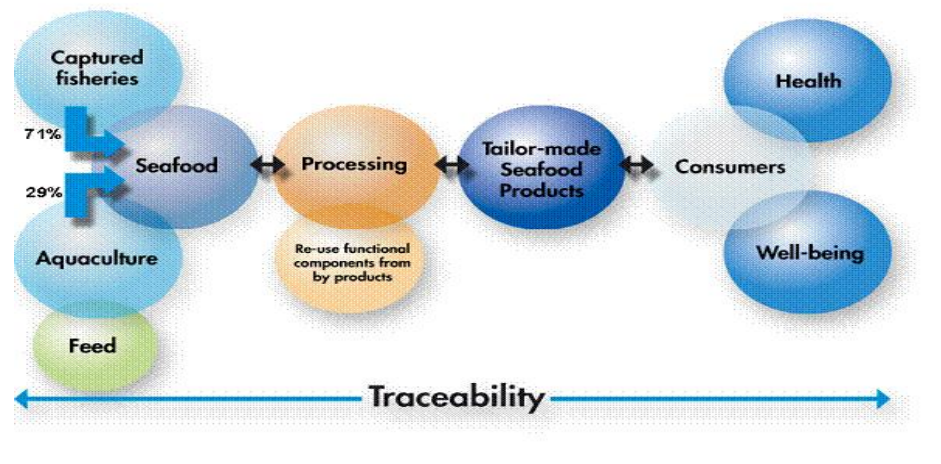
(English Version)

- <http://www.azti.es/>



PLANS FOR THE FUTURE

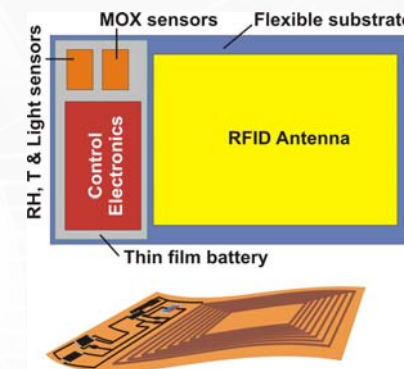
- Validate the software with more fish species and products (fresh and lightly preserved seafood)
- Software: combination of shelf-life models and traceability tools (e.g. data logger or radio frequency identification tags _RFID)



“FOOD SAFETY AND QUALITY WITH MICROSYSTEMS” (FP6-IT-1-508774-IP) FP6-IST-1-508774-IP

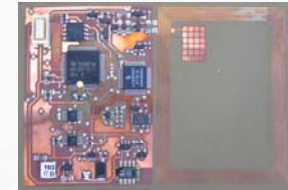
Objective (WP6): Development of a flexible tag for food monitoring during the logistic chain, integrating:

- physical sensors (T^a , rH and light)
- chemical sensors
- RFID communication capabilities



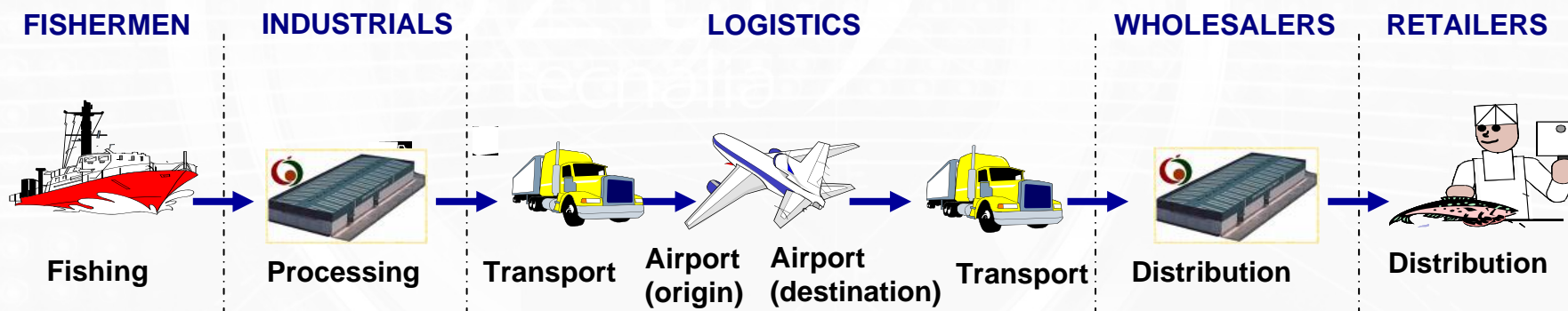
Demostration project: Objective: Implementation of an *online T^a and rH* monitoring system for the fresh fish logistic chain (based on the RFID tag developed)

Methodology: Real-life implementation of the **smart RFID tag** along international fresh fish logistic chain . Field tests: from South-Africa to Spain by airplane and from Frankfurt (Germany) to Vitoria (Spain)



Conclusions: RFID smart tag system developed has been demonstrated and validated along an international fresh fish.

Traceability and cold chain data are stored in the Smart Tag memory



THANK YOU !!

FSLP_Software: AZTI- TECNALIA, Spain Food Research Division

Maidier Nuin
Nerea Argarate
Ziortza Cruz
Bego Alfaro



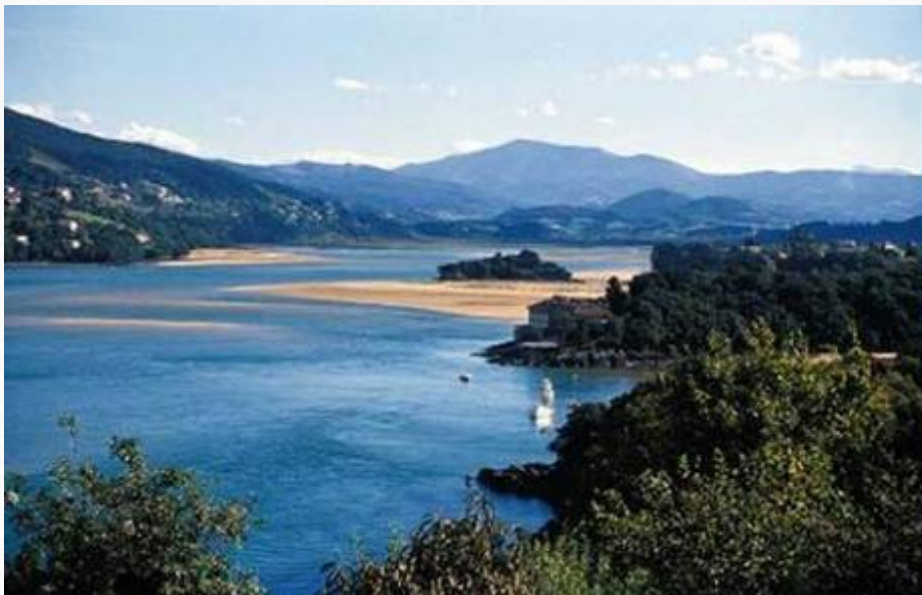
Institute of Food Research, Computational Microbiology Norwich, UK

Carmen Pin
Jozsef Baranyi
Yvan Le Marc



Agriculture and Fisheries Department of the Basque Government for providing financial support for this research.

Thank you for your attention!!!



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