



aquaManager

IMPROVE PRODUCTION EFFICIENCY AND MANAGEMENT IN AQUACULTURE OPERATIONS USING ICT AND DATA MINING TECHNOLOGIES

Konstantinos Bovolis

Marketing Communications Manager

Integrated Information Systems S.A.

aquaManager



FENACAM 2017

November 15 – 18, 2017

Natal, Brazil

Outline

- Aquaculture's present and future
- Management Challenges that producers face
- ICT and Data mining
 - Benefits
 - Examples
 - Business cases
- Additional benefits
- Conclusion



Introduction

Who we are

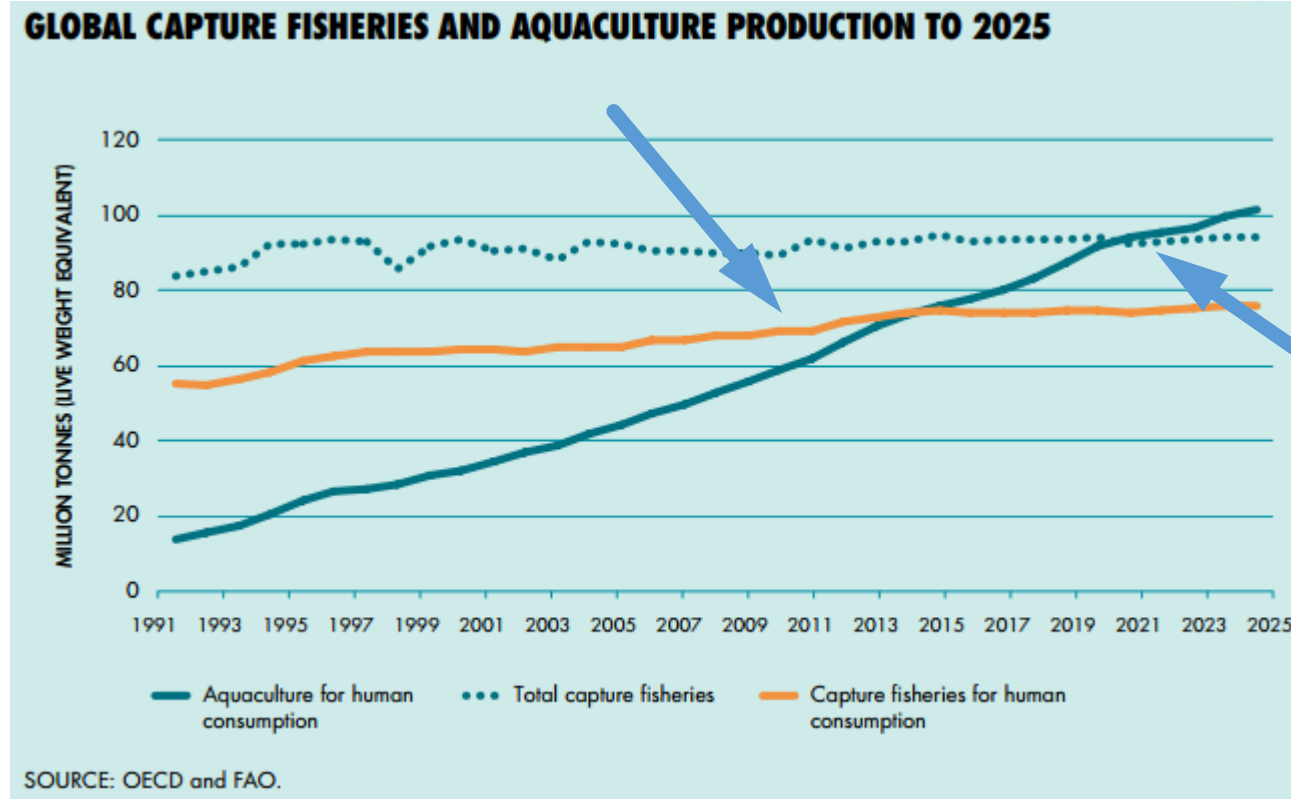


- i2S - aquaManager Team
- More than 20 years of experience in ICT for aquaculture
- Global presence – multiple species
- Research projects with prominent academic institutions
- Multiple publications - presentations in conferences all over the world



Introduction

- Aquaculture surpassed capture fisheries
- Fastest growing animal food producing sector in the world
- Increasing demand for fish protein
- Huge social and economical potential



The Challenge

Key elements of aquaculture production

- **Extremely sensitive** to feed, conversion, health, bio-security
- Feed and health represent **70% of OPEX**
- Making **right decisions**
- **Scheduling**
- **Respond** to challenges in **real time**
- Know what is happening, why it's happening, as it happens



The Challenge

Approach

What a successful company must do - 1

- Check everyday **feeding** (management of fish in general) integrity
- **Evaluate performance** among units – compare this performance to the expected one
- Improve profitability through better **planning**
- **Compare growth, mortality, cost** to the one of the production plan
- **Identify problems** immediately



The Challenge

Approach

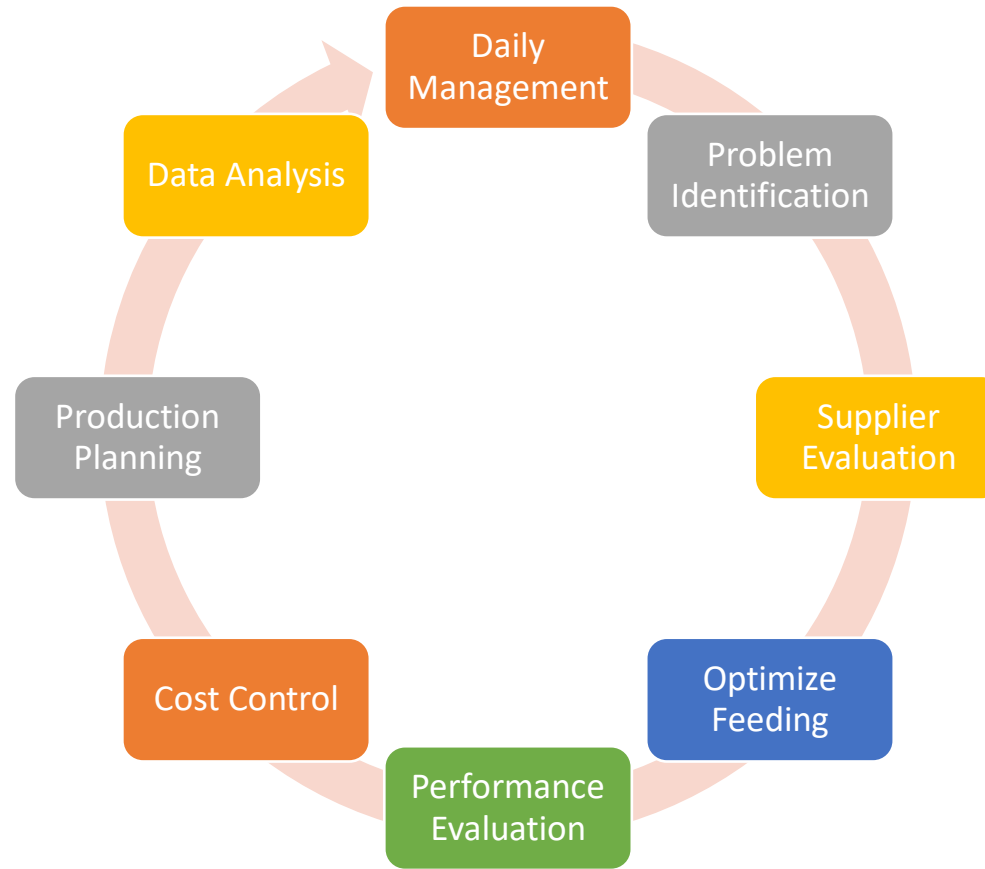
What a successful company must do - 2

- ✎ **Support** management for **decision making**
- ✎ **Evaluate** feed **suppliers** and feeding **policies**
- ✎ Ensure production information is collected - corrected
- ✎ Make best use of **available resources**
- ✎ **Exploit** available **data** to **improve production**
- ✎ And many more...



The Challenge

Sounds like a lot of work!



The Challenge

Can someone do this without a system?

- ✕ Very difficult to control cost drivers
- ✕ No timely identification of production issues or trends
- ✕ Difficult to evaluate feed and fry suppliers
- ✕ Purchasing policies based on **aggregated means**
- ✕ Production planning based on **rough estimations**
- ✕ Higher management cost
- ✕ Mistakes
- ✕ No support for decision-making



ICT Benefits

Benefits of using Information Technology

- ✧ Lower production costs
- ✧ Improved profitability
- ✧ Improved operational efficiency
- ✧ **Management support** for decision-making
- ✧ Efficient and effective **management** of equipment and human resources
- ✧ Production at the **right time**, with the **right size**
- ✧ Improved **product quality**
- ✧ **Supplier evaluation**
- ✧ **Optimization of stock levels** and **purchase policies**

Knowledge Discovery and Data Mining

Data Mining Algorithm is utilized for **descriptive** (discover patterns, rules and trends) or **predictive** tasks

Outcome of DM analysis need to be **evaluated** and **interpreted** so as the acquired **knowledge** to be **valuable** to end-users

Transform preprocessed data to be in a suitable format to Data Mining algorithms

Preprocess the target data removing missing values, detecting outliers and inconsistencies

Data are gathered to DB Systems. **Selecting** data is necessary for analysis

Interpretation - Evaluation

Data Mining

Transformation

Preprocessing

Selection

Patterns/
models

Transformed
Data

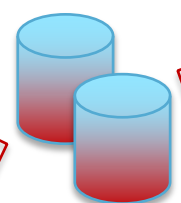
Preprocessed
Data

Target
Data

Understanding



Data

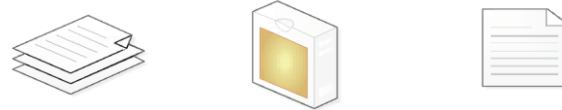


Integrated model of the decision-making process

Level III (top-tier) – The interface of the presentation layer

Decision Support System
Make a decision by Decision Makers

Generating Decision Opportunities



Level II (middle-tier) – model management or analysis layer

Business Intelligence
Tools

Organizational
Learning

Level I (bottom-tier) – data management

Private Data Sources



Public Data Sources



In-depth analysis of data = Performance Improvement

A good IT system provides tools that:

- ✕ Allows the company to understand which units and batches are **in or out-of-control** and **take corrective actions**. Without a system this info comes too little, too late.
- ✕ Continuously **evaluate performance**
- ✕ **Visualize** and **analyze** data. Prevent problems before they escalate.
- ✕ **Optimize** the **feeding strategy**, based on the specific conditions of the farm

Data mining Benefits / 1

Big savings come from data mining

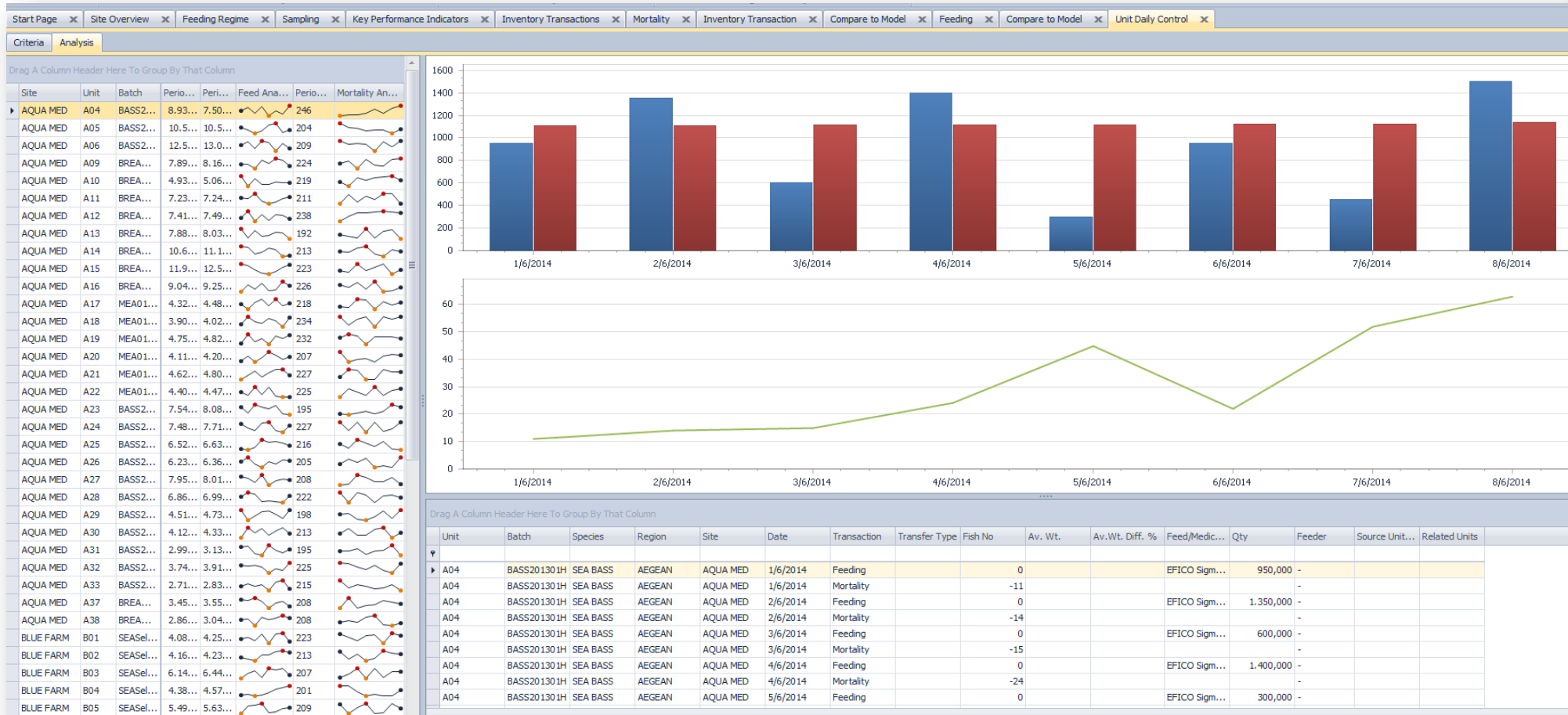
- ✎ Transform data into **knowledge**.
- ✎ Accurate view of the **life to date** fish behavior.
- ✎ Better track of the **living inventory** (biomass)
based on the analysis of all environmental and biological data.
- ✎ **Substantial improvement** of the **growth model**, which has great impact on predictions, business plans efficiency etc.

Data mining benefits /2

- Make **accurate estimations** of the **growth** of the fish and the **result** of the production every day.
- **Minimize uncertainty** and moreover contribute to more precise **production and financial plans**.
- Improve the **quality** and **validity** of the collected data through fraud **detection** and **identification** of false data (outliers)

Let's get more practical....

Example 1 – Feeding Control



Example 2 – Problem Identification

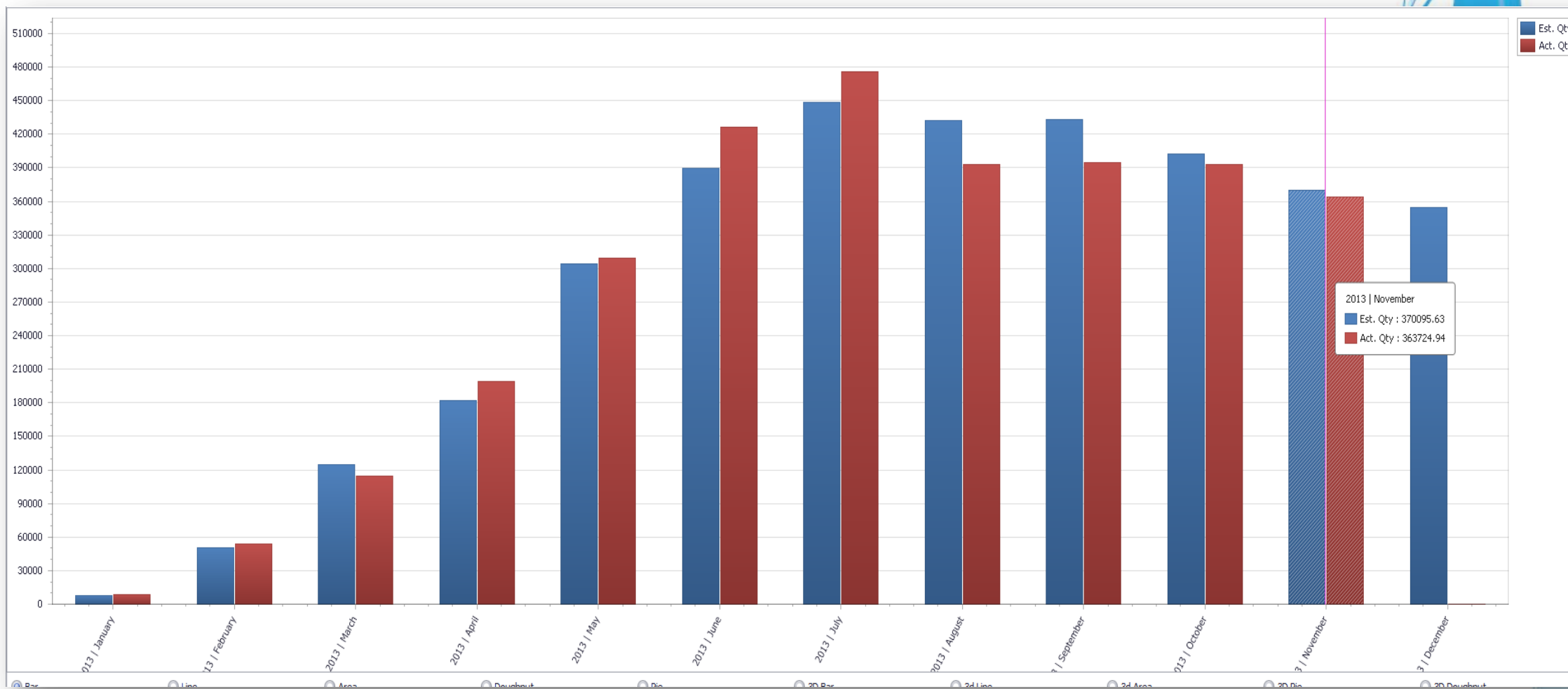
Drag A Column Header Here To Group By That Column

	Alarm	Site	Unit	Species	Batch	Origin	Fish No	Av. Wt.	Biomass	Econ. FCR	Biol. FCR	Av. Wt. Ca...	M %	A%	BFCR	EFCR	Grading	Unit Group	Last G
▼	●												●	●	●	●			
	●	AQUA MED	A04	SEA BASS	BASS201301H	2013	269.907	362,49	97.838,59	2,12	2,01	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A05	SEA BASS	BASS201301H	2013	320.916	361,49	116.007,92	2,10	2,00	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A06	SEA BASS	BASS201301H	2013	377.143	351,49	132.561,99	2,09	2,03	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A09	SEA BREAM	BREAM201...	2013	237.133	362,65	85.996,28	2,05	1,94	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A10	SEA BREAM	BREAM201...	2013	148.857	356,88	53.124,09	2,14	1,93	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A11	SEA BREAM	BREAM201...	2013	220.090	358,17	78.829,64	2,05	1,92	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A12	SEA BREAM	BREAM201...	2013	219.396	347,00	76.130,41	1,97	1,92	X 300 - 500	●	●	●	●		AM1	
▶	●	AQUA MED	A13	SEA BREAM	BREAM201...	2013	234.401	345,54	80.994,92	1,97	1,93	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A14	SEA BREAM	BREAM201...	2013	313.916	347,12	108.966,52	1,97	1,93	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A15	SEA BREAM	BREAM201...	2013	359.198	354,22	127.235,12	1,96	1,93	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A16	SEA BREAM	BREAM201...	2013	273.907	359,56	98.486,00	1,96	1,93	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A17	MEAGRE	MEA01301S	2013	103.836	680,00	70.608,48	1,55	1,48	Z 500 - 1000	●	●	●	●		AM1	
	●	AQUA MED	A18	MEAGRE	MEA01301S	2013	93.743	680,00	63.745,24	1,55	1,47	Z 500 - 1000	●	●	●	●		AM1	
	●	AQUA MED	A19	MEAGRE	MEA01301S	2013	113.674	680,00	77.298,32	1,57	1,50	Z 500 - 1000	●	●	●	●		AM1	
	●	AQUA MED	A20	MEAGRE	MEA01301S	2013	98.926	680,00	67.269,68	1,56	1,49	Z 500 - 1000	●	●	●	●		AM1	
	●	AQUA MED	A21	MEAGRE	MEA01301S	2013	109.045	680,00	74.150,60	1,50	1,44	Z 500 - 1000	●	●	●	●		AM1	
	●	AQUA MED	A22	MEAGRE	MEA01301S	2013	103.882	555,75	57.732,42	1,85	1,76	Z 500 - 1000	●	●	●	●		AM1	
	●	AQUA MED	A23	SEA BASS	BASS201301N	2013	234.458	326,33	76.510,68	2,18	2,13	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A24	SEA BASS	BASS201301N	2013	234.244	324,03	75.902,08	2,17	2,12	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A25	SEA BASS	BASS201301N	2013	204.079	323,99	66.119,56	2,17	2,11	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A26	SEA BASS	BASS201301N	2013	194.066	325,30	63.129,67	2,19	2,13	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A27	SEA BASS	BASS201301N	2013	249.001	323,93	80.658,89	2,17	2,13	X 300 - 500	●	●	●	●		AM1	
	●	AQUA MED	A28	SEA BASS	BASS201301N	2013	204.177	349,94	71.449,70	2,08	2,03	X 300 - 500	●	●	●	●			
	●	AQUA MED	A29	SEA BASS	BASS201301N	2013	134.568	351,76	47.335,64	2,10	2,03	X 300 - 500	●	●	●	●			
	●	AQUA MED	A30	SEA BASS	BASS201301N	2013	123.929	355,31	44.033,21	2,13	2,05	X 300 - 500	●	●	●	●			
	●	AQUA MED	A31	SEA BASS	BASS201301H	2013	89.134	365,00	32.533,91	2,17	2,06	X 300 - 500	●	●	●	●			
	●	AQUA MED	A32	SEA BASS	BASS201301H	2013	100.040	354,10	40.753,70	2,16	2,06	X 300 - 500	●	●	●	●			

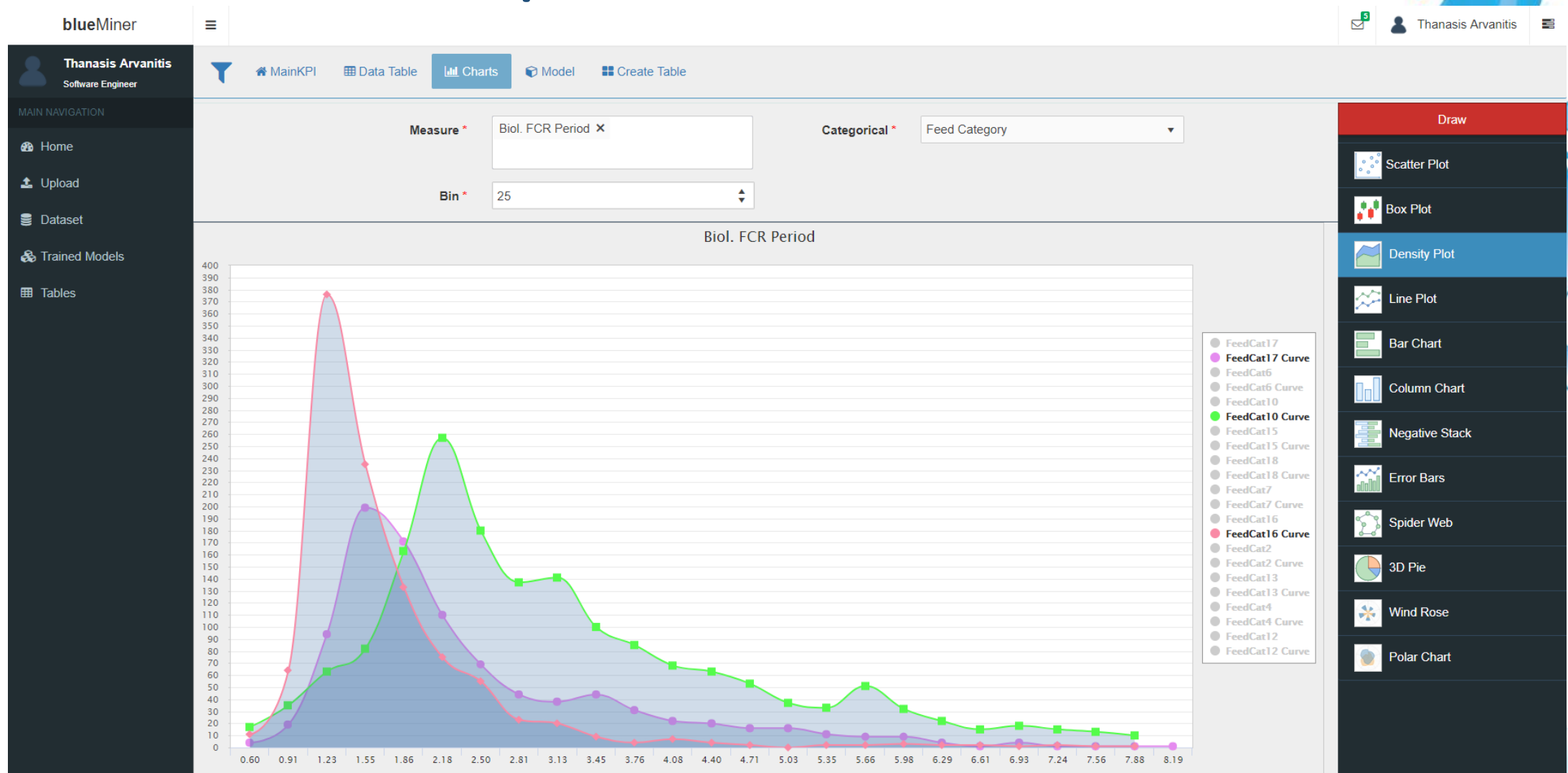
Example 3 – Performance Benchmarking

Calculate Model																		
SFR Adjustments							FCR Adjustments				Start Date							
<input checked="" type="radio"/> User Defined <input type="radio"/> Default							<input checked="" type="radio"/> User Defined <input type="radio"/> Default				<input checked="" type="radio"/> Fish Stocking <input type="radio"/> Unit Start			<input type="checkbox"/> Project to Target				
Details							Average Weight			Mortality %			Food / Kg			FCR		
Last Sampli...	Last Harve...	Unit	Batch	Species	Fish No	Grading	Actual	Model	Deviation %	Actual	Model	Deviation %	Actual	Model	Deviation %	Actual	Model	Deviation %
30/6/2014		A12	BREAM201...	SEA BREAM	219.396		347,00	311,21	11,50	6,64	9,79	32,18	1,95	2,68	27,05	1,97	2,70	27,21
30/6/2014		A13	BREAM201...	SEA BREAM	234.401		345,54	311,21	11,03	6,24	9,79	36,27	1,95	2,68	27,07	1,97	2,70	27,22
30/6/2014		A14	BREAM201...	SEA BREAM	313.916		347,12	312,57	11,05	4,87	9,74	49,98	1,95	2,69	27,36	1,97	2,71	27,42
30/6/2014		A15	BREAM201...	SEA BREAM	359.198		354,22	314,34	12,69	4,21	9,73	56,65	1,95	2,69	27,69	1,96	2,71	27,79
30/6/2014		A16	BREAM201...	SEA BREAM	273.907		359,56	317,41	13,28	5,55	9,74	63,03	1,95	2,69	27,49	1,96	2,72	27,68
30/6/2014		A17	MEA01301S	MEAGRE	103.836		680,00	512,99	32,56	13,47	7,38	-82,52	1,54	2,44	36,85	1,55	2,46	37,02
30/6/2014		A18	MEA01301S	MEAGRE	93.743		680,00	512,88	32,58	14,78	7,39	-99,99	1,55	2,44	36,67	1,55	2,46	36,84
30/6/2014		A19	MEA01301S	MEAGRE	113.674		680,00	514,27	32,23	12,56	7,18	-74,91	1,56	2,47	36,81	1,57	2,49	36,90
30/6/2014		A20	MEA01301S	MEAGRE	98.926		680,00	513,58	32,40	13,98	7,24	-93,06	1,55	2,46	36,93	1,56	2,48	37,03
30/6/2014		A21	MEA01301S	MEAGRE	109.045		680,00	513,00	32,55	12,76	7,38	-72,95	1,50	2,44	38,64	1,50	2,46	38,80
30/6/2014		A22	MEA01301S	MEAGRE	103.882		555,75	513,16	8,30	13,43	7,30	-84,00	1,84	2,45	25,07	1,85	2,47	25,14
30/6/2014		A23	BASS201301N	SEA BASS	234.458		326,33	298,49	9,33	6,22	9,41	33,93	2,16	3,00	27,87	2,18	3,02	27,94
30/6/2014		A24	BASS201301N	SEA BASS	234.244		324,03	297,71	8,84	6,30	9,46	33,38	2,15	2,99	28,01	2,17	3,02	28,17
30/6/2014		A25	BASS201301N	SEA BASS	204.079		323,99	295,93	9,48	7,24	9,45	23,42	2,15	2,99	28,01	2,17	3,01	28,12
30/6/2014		A26	BASS201301N	SEA BASS	194.066		325,30	301,11	8,03	7,59	9,42	19,45	2,18	2,99	27,22	2,19	3,02	27,36
30/6/2014		A27	BASS201301N	SEA BASS	249.001		323,93	297,71	8,81	6,04	9,46	36,18	2,16	2,99	27,80	2,17	3,02	27,96
30/6/2014		A28	BASS201301N	SEA BASS	204.177		349,94	295,93	18,25	7,19	9,45	23,89	2,06	2,99	30,98	2,08	3,01	31,12
30/6/2014		A29	BASS201301N	SEA BASS	134.568		351,76	297,71	18,16	10,29	9,46	-8,75	2,09	2,99	30,09	2,10	3,02	30,26
30/6/2014		A30	BASS201301N	SEA BASS	123.929		355,31	302,36	17,51	11,48	9,41	-21,99	2,12	3,00	29,45	2,13	3,03	29,50
30/6/2014		A31	BASS201301H	SEA BASS	89.134		365,00	297,63	22,64	13,10	9,65	-35,79	2,15	3,00	28,26	2,17	3,02	28,25
30/6/2014		A32	BASS201301H	SEA BASS	108.943		374,12	297,63	25,70	10,95	9,65	-13,44	2,14	3,00	28,56	2,16	3,02	28,57
30/6/2014		A33	BASS201301H	SEA BASS	78.835		374,54	297,63	25,84	14,62	9,65	-51,45	2,17	3,00	27,50	2,19	3,02	27,50
30/6/2014		A37	BREAM201...	SEA BREAM	99.040		378,27	311,21	21,55	11,54	9,79	-17,90	2,02	2,68	24,52	2,04	2,70	24,68
30/6/2014		A38	BREAM201...	SEA BREAM	83.869		369,96	311,21	18,88	13,56	9,79	-38,50	2,04	2,68	23,81	2,06	2,70	23,95
30/6/2014		B01	SEASel201301	SEA BASS	184.047		191,82	218,43	-12,18	7,98	9,43	15,41	2,34	2,71	13,66	2,37	2,74	13,67

Example 4 – Optimized feeding strategies



Example 5 – Feed evaluation



Business case – Feeding Optimization

Company

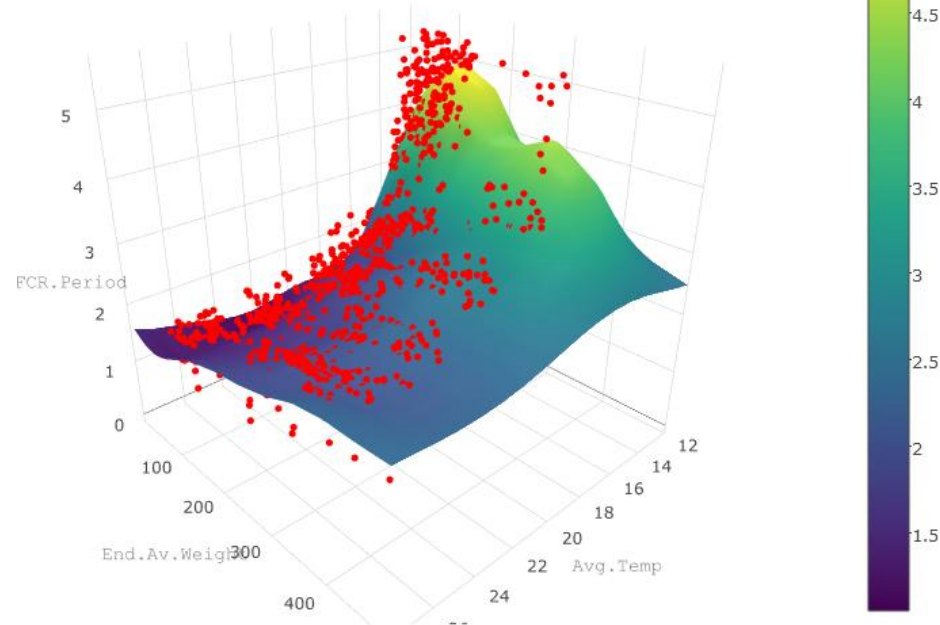
Open Sea, Cages, 5000 tons / year

Achievement

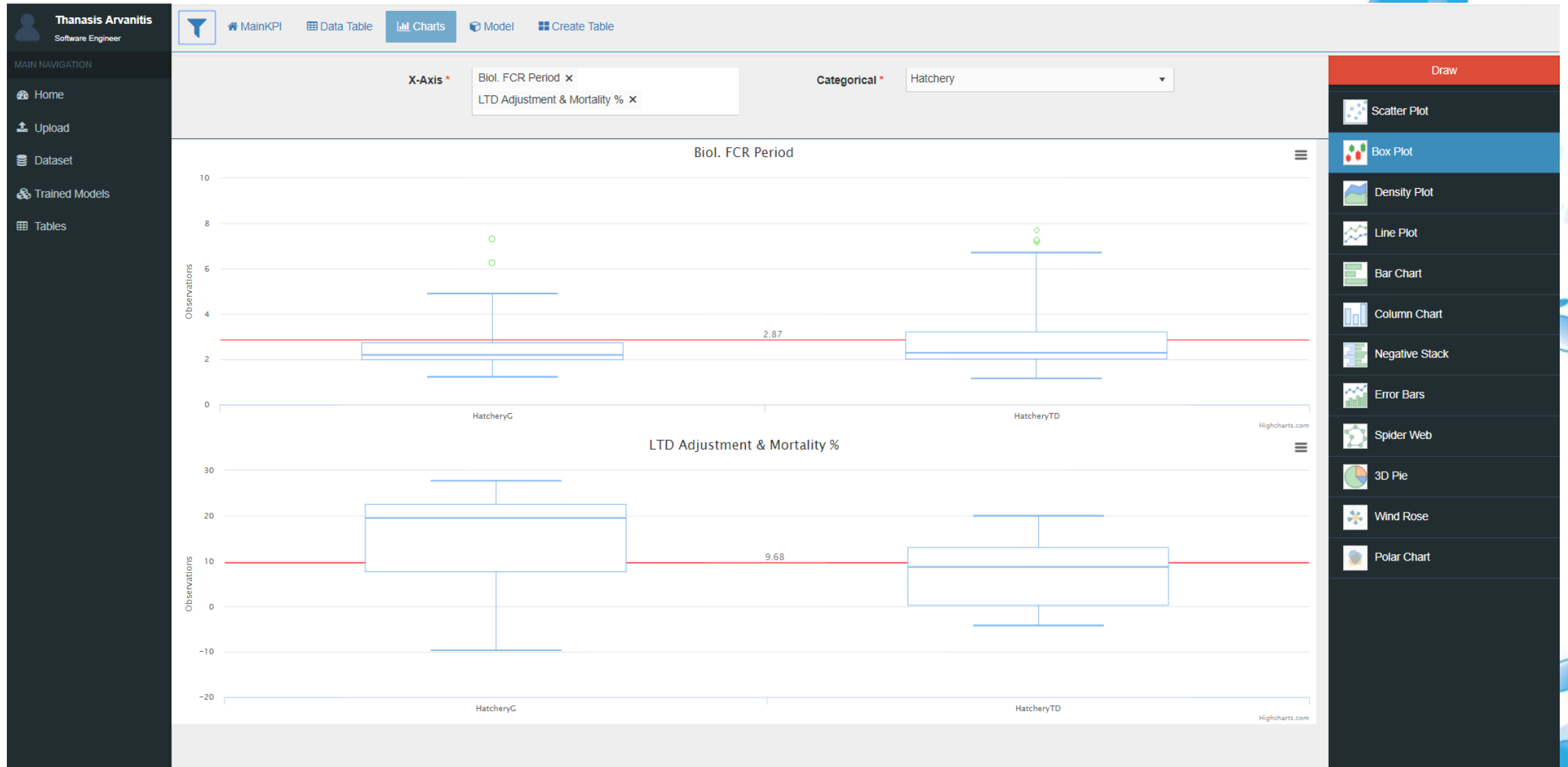
Development of new, optimized Feeding and Growth Models, using advanced data mining technologies

Improvement

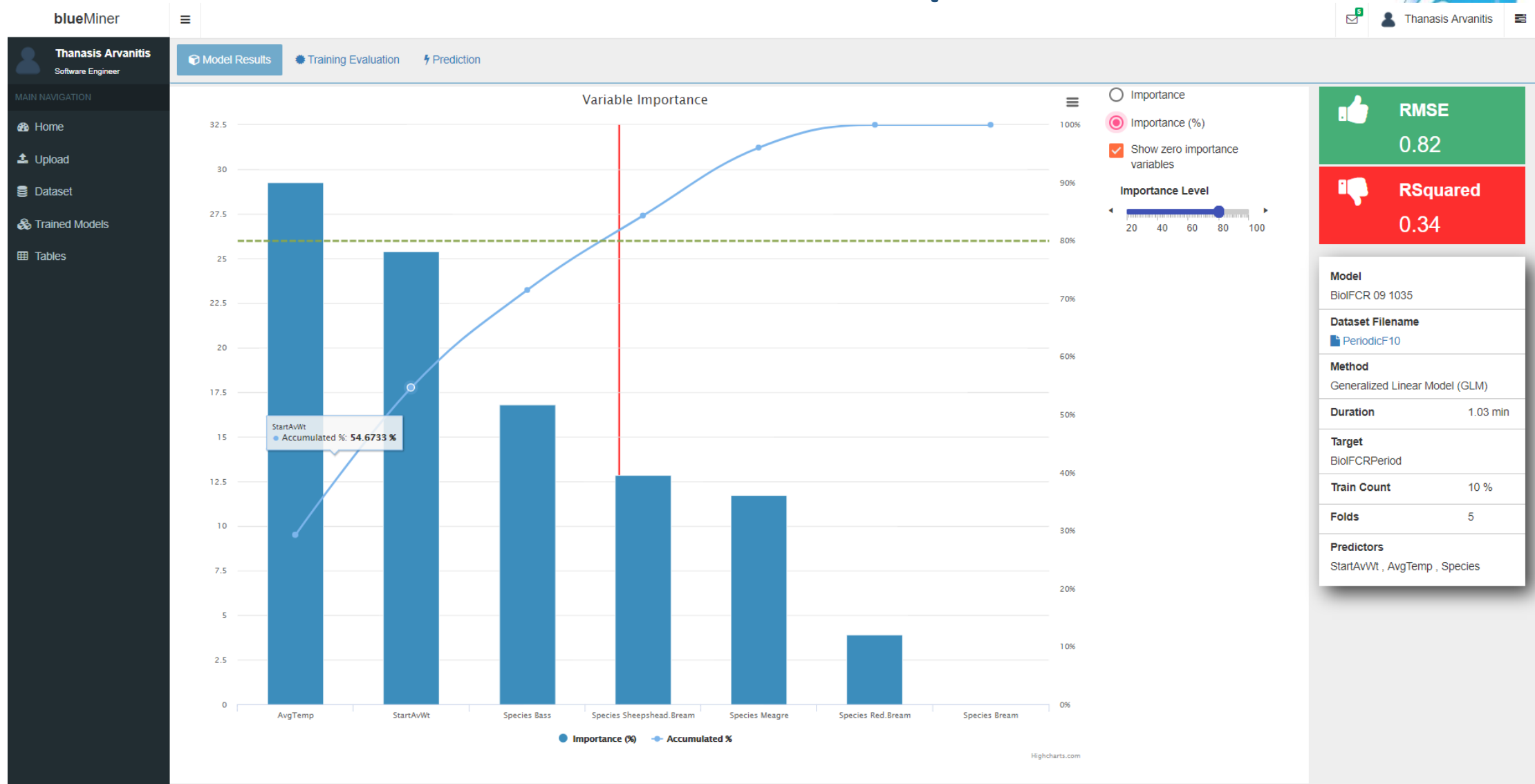
Reduction of feed cost by 6,8 %



Example 6 – Hatchery Evaluation



Example 8 – Where to focus for improvement



Business case – Understanding and improving performance

Company

Open Sea, Cages, 12500 tons / year

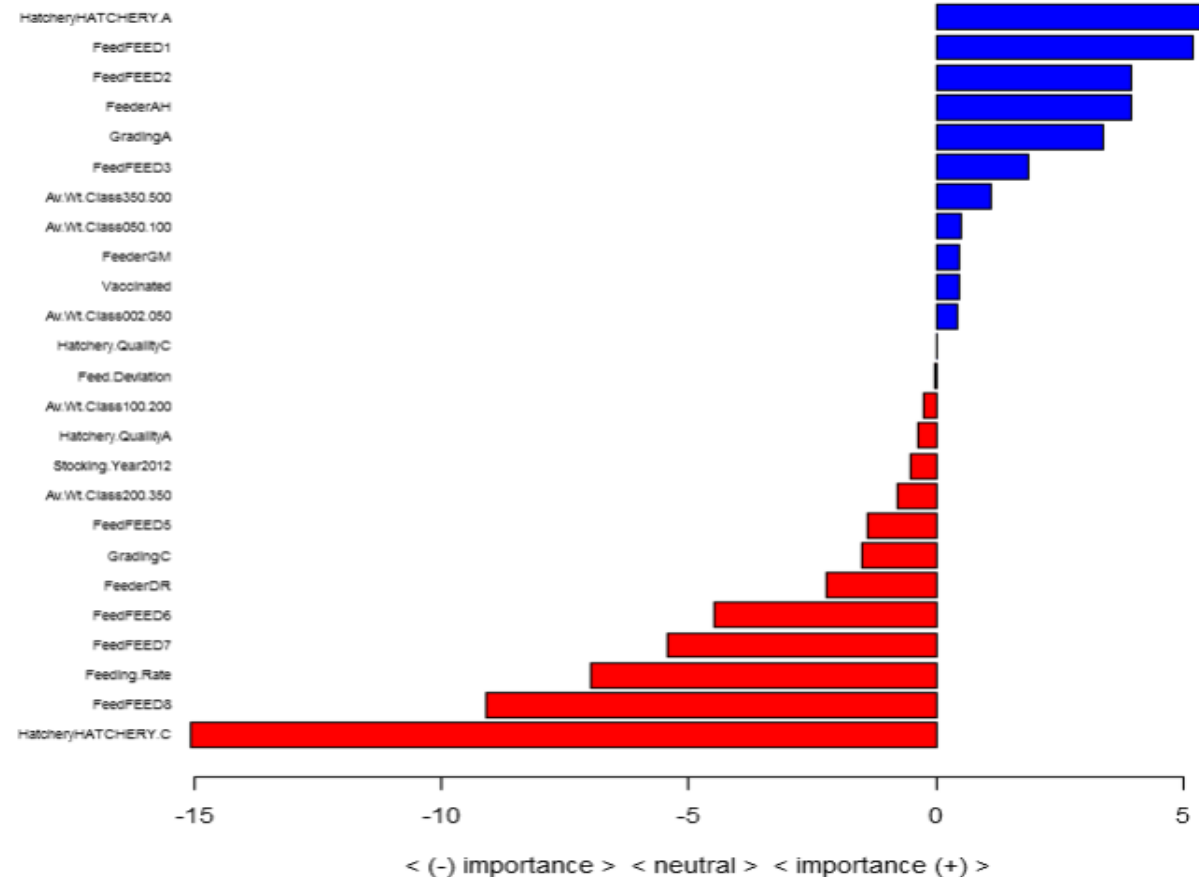
Achievement

Understanding and predicting the impact of various parameters on the fish production process

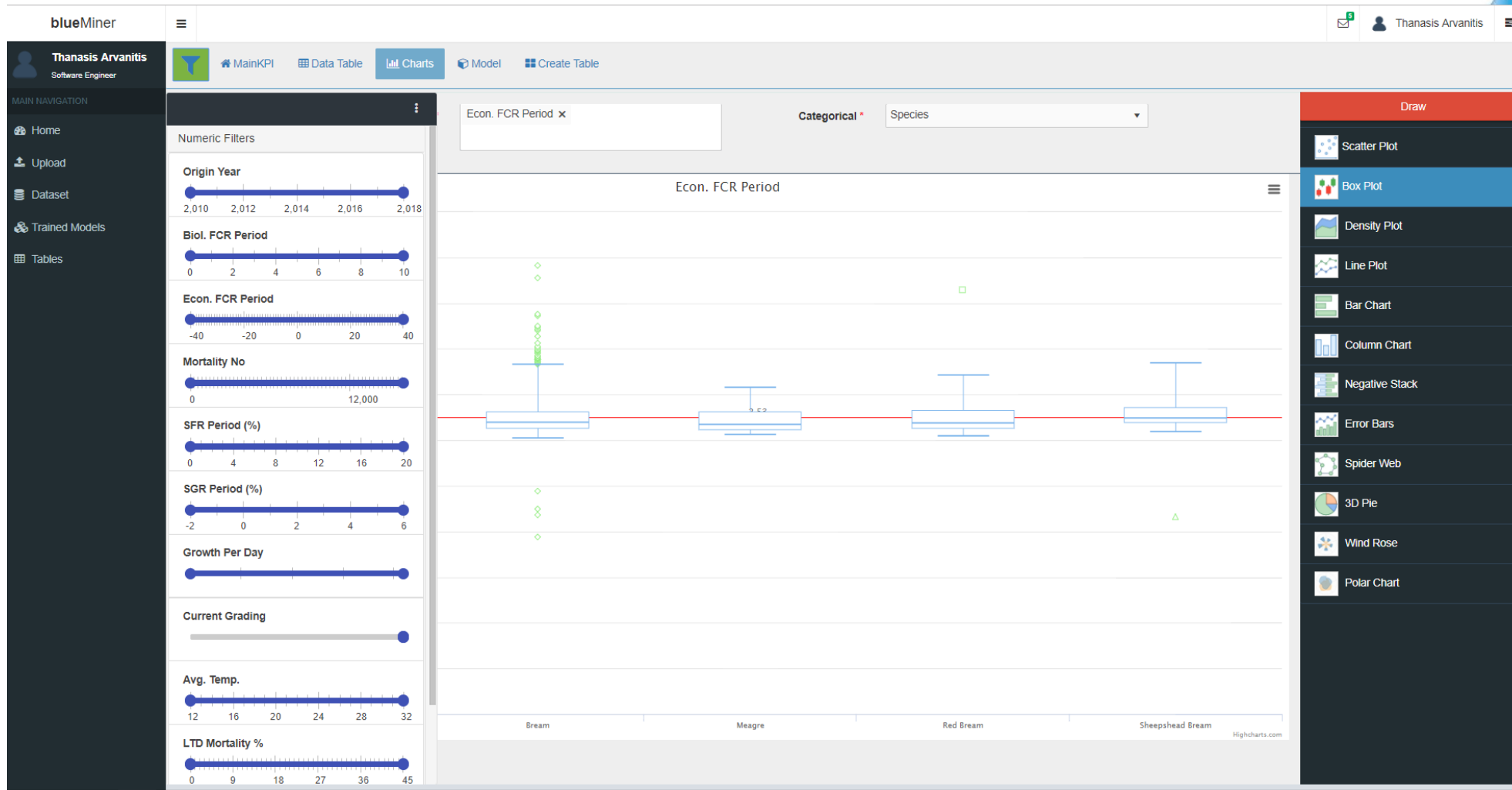
Improvement

Selection of best feed suppliers, fry suppliers and optimization of fish management practices. Reduction of mortalities by 8,4% and cost by 6,2%

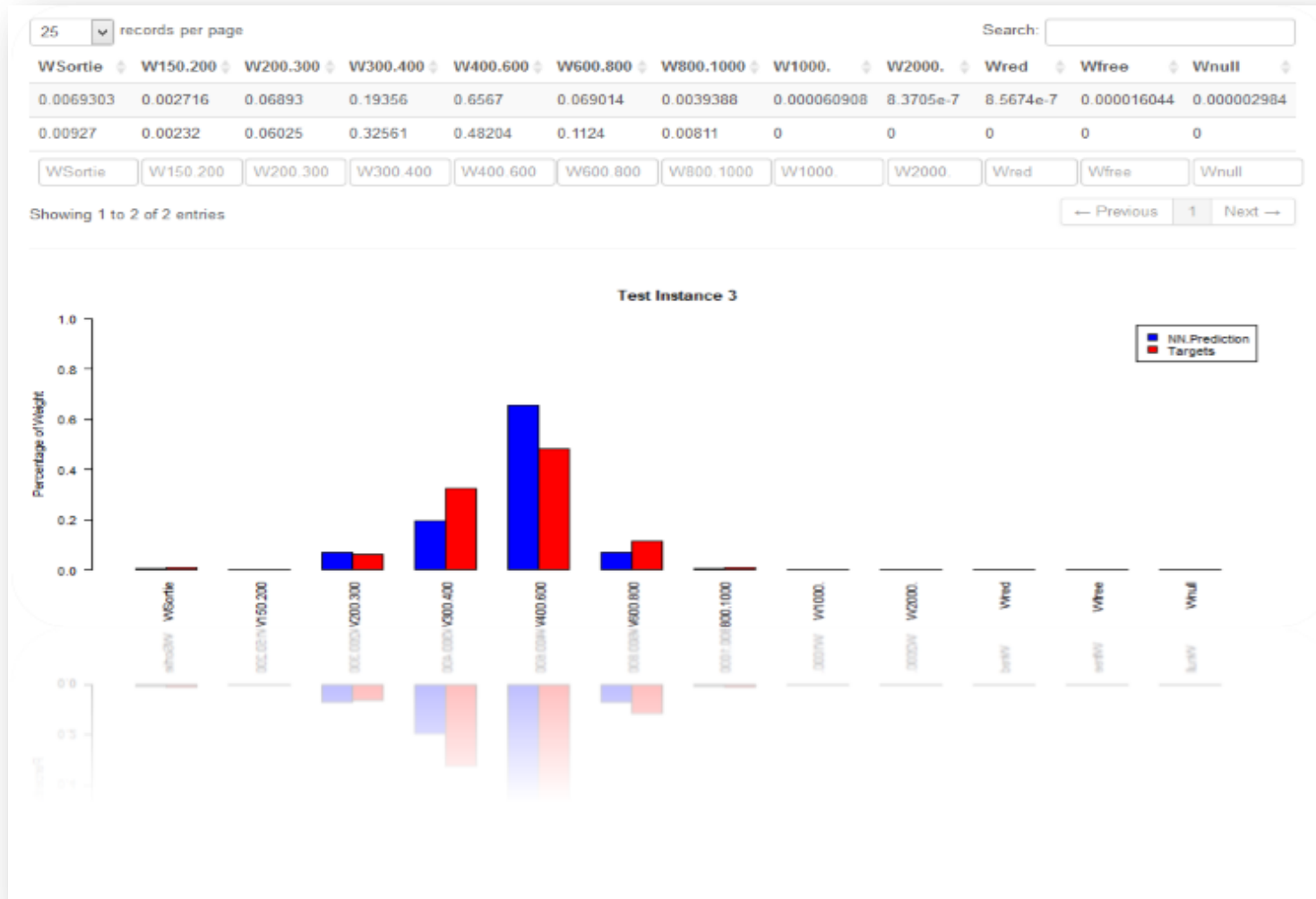
Variable Importance using GLM model



Example 9 – Data Validity



Example 10 - Prediction of harvest distribution



Business case – Fish number and avg. weight estimation

Company

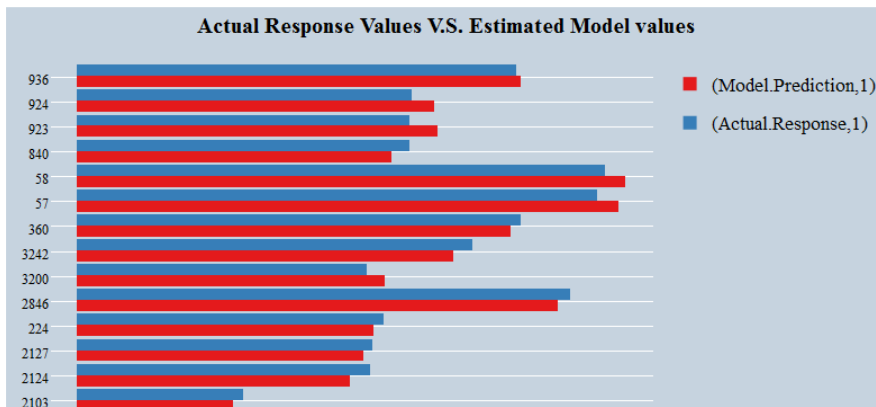
Open Sea, Cages, 2500 tons / year

Achievement

Automatic identification of fish populations with performance problem or populations where fish are missing, using data between samplings and machine learning models

Improvement

Optimization of feeding based on the actual biomass. Reduction of feed cost by 7,3% in a period of one year.



Cost Analysis

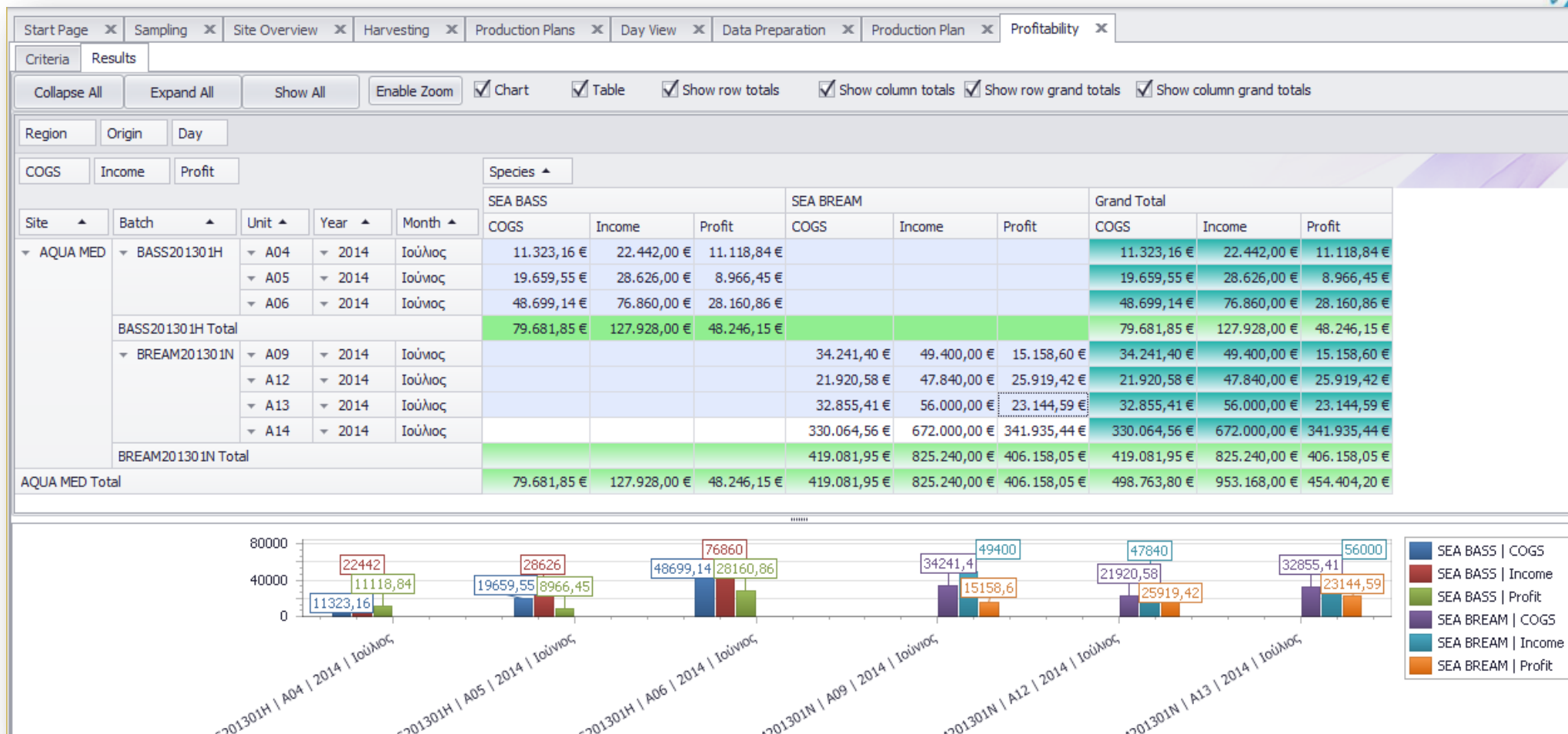
First step to reduce costs?



Know the cost!

- 🔍 Do you know the cost of every unit, batch?
- 🔍 Do you know the profitability of every harvest?
- 🔍 Are you able to make an in-depth audit of the current expenditure?

Example – Profitability of each harvest



Higher Profitability

- ✧ Cost reduction can increase profitability.

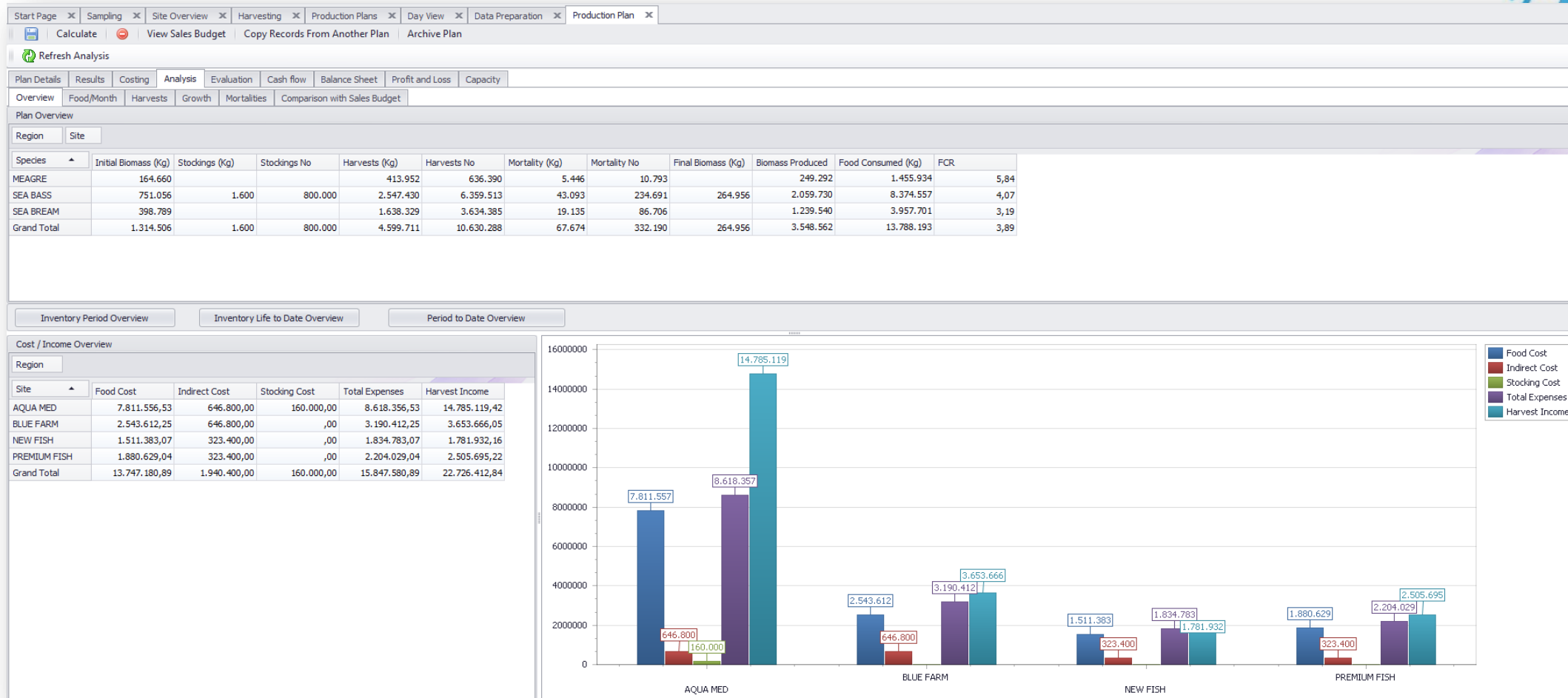
In many cases big profits come from well-designed, optimized **production plans**

- ✧ A good plan must **maximize the profit margin**

- ✧ You need to create a number of alternative, viable budgets and **select the most profitable one.**



Example – Production Planning



Business case - Prediction of production KPIs

Company

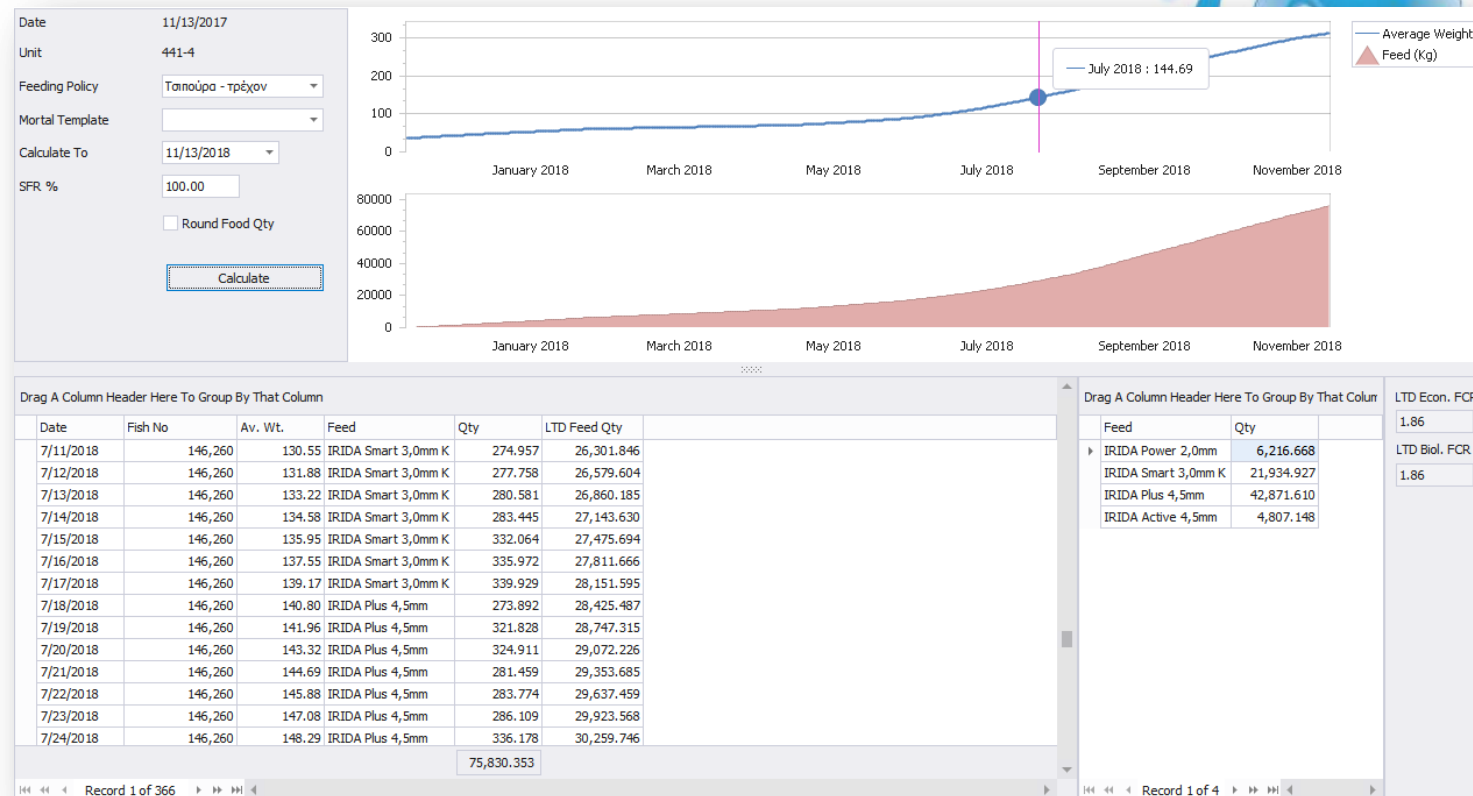
Open Sea, Cages, 4200 tons / year

Achievement

More accurate production plans, the company knows exactly what size of fish will be available and when.

Improvement

Increased credibility of the company, higher prices



Operational Efficiency

- Workflow establishment
- Much more **organized** work, **mentality changes**
- Real time notification for the management crew in case of a problem
- Management reports generated **immediately**. Allows production managers to **save time, reduce paperwork, increase efficiency**

Data quality

- Quick and easy input of production data into a system
- Less time required for data entry
- Data Integrity. No more mistakes. Self control.
- Find the specific information needed to make better decisions, optimize workflow

Management support for decision-making

- With all your data in one place, an IT system makes it easy to **access** and **analyze** data.
 - Pivot tables
 - Charts
 - Customized to your actual requirements
- Reports produced **instantly**
- Effectively **analyze performance** and **take decisions** at any level

Better Services to customers

- Immediate and documented reply to complaints
- Quality certificates with information gathered during the life cycle of the fish
- IT system supports full **traceability** of the produced fish and production processes.
A major requirement of the certification bodies

Knowledge Base

- ✎ Development of a knowledge base with valuable information on **fish growth and quality, best practices, growth policies and environmental data.**
- ✎ Knowledge stays in the company even if a key staff member leaves
- ✎ New colleagues can easily learn how the farm operates and get productive quickly

Knowledge Base



AQUAMANAGER CLIENTS

From automated data collection, to advanced reporting to business intelligence and data mining.

Thank you for your attention!!!



We will be happy to hear from you!

If you have any comments, ideas or you would like to learn more, you may email me directly: kbovolis@aqua-manager.com

Or you can visit our website
<https://www.aqua-manager.com/>