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 “The Knowledge Base for Fisheries Management”

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PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
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Overview of models, data and software used in contrasting Fisheries Management Systems

Annex Report to EFIMAS Work Package 2 Technical Report:
“The Knowledge Base for Fisheries Management”

Introduction

This report aims to provide overview information on the diversity of fisheries management systems presented and discussed in the EFIMAS WP2 Technical Report “The Knowledge Base for Fisheries Management”, 2006, Eds. Lorenzo Motos and Douglas Wilson. The report covers sixteen different fisheries regions across the World including Europe, North America and Oceania. It serves as an “annex report” providing information to EFIMAS partners on some of the most common management systems applied in representative fisheries around the world. Secondly, it serves as a quick guide for management officers, stakeholders and other interested parties on available information on fisheries assessment and management, including required input data, analysis tools, models, software, reference points, advisory bodies, management tools, legal instruments and management bodies and agencies.

This report has been prepared by a multidisciplinary team of fisheries scientist, including biologist, economists and sociologists. The table below shows the fisheries and management systems covered addressed in the report.

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1. Shared stocks management: Arcto Norwegian Cod, Europe

1. SYSTEM	Shared stocks management
2. STOCK	Arcto Norwegian cod stock
3. NEEDED INPUT DATA	<p>Biological stock data, e.g.:</p> <ul style="list-style-type: none"> • Catch in weight • Catch at age (numbers) • Weight at age (in the catch) • Proportion mature by age • Length composition in catch • Tuning CPUE series • Cod predation matrix
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • XSA • FLEKSIBEST (experimental) • Others
5. OUTPUT TO REFERENCE POINTS	n/a
6. FORECAST MODELS	<ul style="list-style-type: none"> • IFAP-ICES for short term • RISK@ for medium term
7. SOFTWARE	<ul style="list-style-type: none"> • Lowestoft VPA suite • FLEKSIBEST
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • ICES (ACFM) • Assessment by: Working Group on Arctic Fisheries
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • IMR (Norway) • PINRO (Russia) • IfM-GEOMAR (Germany) • IEO-AZTI (Spain)
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • Shared, cooperative management • TAC with quota exchange • % Quota for third countries (Paris treaty) <p>Tools:</p> <ul style="list-style-type: none"> • HCR tested by a population simulation model • PROST (projections) <p>Legal instrument:</p> <ul style="list-style-type: none"> • Norwegian-Russian agreement <p>Bodies:</p> <ul style="list-style-type: none"> • EU • Third countries • Regional Management Councils (NEAGC, NAFO) • E.g.: Norwegian-Russian commission

2. Shared stocks management: Northern stock of Hake, Europe

1. SYSTEM	Shared stocks management
2. STOCK	Northern stock of hake
3. NEEDED INPUT DATA	<p>Biological stock data, e.g.:</p> <ul style="list-style-type: none"> • Landing in weight • Catch at age (numbers) • Weight at age (in the catch) • Proportion mature by age • Length composition in catch • Tuning CPUE series
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • XSA
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Blim = Bloss
6. FORECAST MODELS	<ul style="list-style-type: none"> • MFDP • MYPR • MLA suite
7. SOFTWARE	<ul style="list-style-type: none"> • Lowestoft VPA suite • MLA suite • MFDP suite • MYPR suite • PASOFT EXCEL AD –IN
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • STECF • ICES (ACFM) • Assessment by: Working Group on the Assessment of hake, monk and megrim
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • AZTI (Spain) • IEO (Spain) • IFREMER (France) • MARINE INSTITUTE (Ireland) • CEFAS (UK) • DIFRES (Denmark) • BELGIUM
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC • QUOTA <p>Tools:</p> <ul style="list-style-type: none"> • MTAC AND F3 experimental trials <p>Legal instrument:</p> <ul style="list-style-type: none"> • Arcachon agreement • EU recovery plan <p>Bodies:</p> <ul style="list-style-type: none"> • EU

3. Shared stocks management: Hake stock in the Mediterranean, Europe

1. SYSTEM	Shared stocks management (SSM)
2. STOCK	Hake stocks in the Mediterranean – based on GFCM division areas.
3. NEEDED INPUT DATA	<ul style="list-style-type: none"> • Catch in weight • Catch at age (numbers) • Weight at age (in the catch) • Proportion mature by age • Length composition in catch • Fleet capacity
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • FiSAT (FAO) • VIT
5. OUTPUT TO REFERENCE POINTS	
6. FORECAST MODELS	
7. SOFTWARE	<ul style="list-style-type: none"> • FAO_FiSAT package • VIT
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • GFCM through SAC – WG ON DEMERSALS
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • GFCM countries and/or various national Institutions
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • Fleet capacity regulation • Spatiotemporal fishery closures • Technical measures <p>tools:</p> <ul style="list-style-type: none"> • Adaptive management <p>Legal instrument:</p> <ul style="list-style-type: none"> • CFP in the Mediterranean (only for EU waters) <p>Bodies:</p> <ul style="list-style-type: none"> • EU • GFCM

4. Property rights: New Zealand Snapper

1. SYSTEM	Right based management
2. STOCK	Snapper fishery, New Zealand
3. NEEDED INPUT DATA	<p>TAC setting:</p> <ul style="list-style-type: none"> • Catch-at-age/length/stage/sex • Environmental/habitat correlations • Sex and stage structure • Tagging data <p>TAC division (initial allocation)</p> <ul style="list-style-type: none"> • A panel of individualised catches (about 5 years) • Vessel characteristics • Recent investments <p>Enforcement:</p> <ul style="list-style-type: none"> • Individualised quota landings • Buy-sale registers <ul style="list-style-type: none"> -quota buyers-sellers -fish buyers-sellers
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • ITCAAN MODEL • Bayesian integrated model
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Bt/BMSY* • Bt+20/BMSY** • P(Bt+20/Bt) ** • P(Bt+20/BMSY) ** • E(Bt+20/BMSY) ** <p>* under status quo TACC & deterministic recruitment **under status quo TACC & stochastic recruitment</p>
6. FORECAST MODELS	<ul style="list-style-type: none"> • Age structured short term model • Mid-term catch at age model • Long term catch at age model • Integrated tagging and catch at age analysis • A spatially explicit model
7. SOFTWARE	<ul style="list-style-type: none"> • ADBM • (A set of C++ libraries) • MULTIFAN-CL stock assessment model • (AUTODIF library)
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • SeaFic • NIWA • TROPHIA <p>Assessment by: FAWG - Contestable research - Cooperation between industry and government scientists</p>
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • MoF (NZ) • SeaFic • NIWA • Any data available by all parties to perform alternative assessments

10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none">• ITQs• Cost recovery <p>Tools:</p> <p>Legal instrument:</p> <p>Bodies:</p> <ul style="list-style-type: none">• N Zealand MoF• Regional Management bodies: WCPFC• Regional Advisory Bodies:• APFIC• FFA <p>Scientific Bodies:</p> <ul style="list-style-type: none">• SPC
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5. Property rights: Netherlands mixed flatfish fisheries: sole and plaice, Europe

1. SYSTEM	Right based management
2. STOCK	Mixed Flatfish fishery of Sole and Plaice, Netherlands
3. NEEDED INPUT DATA	<p>TAC setting:</p> <ul style="list-style-type: none"> • Catch-at-age/sex • Environmental/habitat correlations • Sex and age structure • Market sampling programmes of landings and • Sampling programmes discards <p>TAC division:</p> <ul style="list-style-type: none"> • Relative stability EU • National ITQ holders • Sharing of national quota <p>Enforcement:</p> <ul style="list-style-type: none"> • Logbooks • Individualised quota
4. ADVISORY/ANALYSIS TOOLS	n/a
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • $B_t/BMSY^*$ • $B_{t+20}/BMSY^{**}$ • $P(B_{t+20}/B_t)^{**}$ • $P(B_{t+20}/BMSY)^{**}$ • $E(B_{t+20}/BMSY)^{**}$ <p>* under status quo TACC & deterministic recruitment **under status quo TACC & stochastic recruitment</p>
6. FORECAST MODELS	<ul style="list-style-type: none"> • Age structured short term model • Mid-term catch at age model • Long term catch at age model • Integrated discarding and catch at age analysis
7. SOFTWARE	<ul style="list-style-type: none"> • FLR XSA
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • ICES assessment: WG Demersal fisheries North Sea
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Marine institutes in ICES member states
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • ITQs • Co-management • EU recovery plan cod (effort limitation) <p>Legal instrument:</p> <ul style="list-style-type: none"> • Fisheries Law 1963 The Netherlands • EU CFP <p>Bodies:</p> <ul style="list-style-type: none"> • EU • Netherlands Ministry of Agriculture, Nature and Food • Regional Advisory Bodies (RAC) North sea

6. Co-management: Netherlands mixed flatfish fisheries: sole and plaice, Europe

1. SYSTEM	Co-management
2. STOCK	Mixed Flatfish fishery of Sole and Plaice, Netherlands
3. NEEDED INPUT DATA	<p>TAC setting:</p> <ul style="list-style-type: none"> Catch-at-age/sex -environmental/habitat correlations Sex and age structure Market sampling programmes of landings and Sampling programmes discards <p>TAC division:</p> <ul style="list-style-type: none"> Relative stability EU National ITQ holders Share of national quota <p>Enforcement:</p> <ul style="list-style-type: none"> Logbooks Individualised quota landings Quota management groups
4. ADVISORY/ANALYSIS TOOLS	n/a
5. OUTPUT TO REFERENCE POINTS	B_t/B_{MSY} * B_{t+20}/B_{MSY} ** $P(B_{t+20}/B_t)$ ** $P(B_{t+20}/B_{MSY})$ ** $E(B_{t+20}/B_{MSY})$ ** <p>* under status quo TACC & deterministic recruitment **under status quo TACC & stochastic recruitment</p>
6. FORECAST MODELS	<ul style="list-style-type: none"> Age structured short term model Mid-term catch at age model Long term catch at age model Integrated discarding and catch at age analysis
7. SOFTWARE	<ul style="list-style-type: none"> FLR XSA
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> ICES assessment: WG Demersal fisheries North Sea
9. ORIGIN OF DATA	<ul style="list-style-type: none"> Marine institutes in ICES member states Any data available by all parties to perform alternative assessments
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> ITQs Co-management EU recovery plan cod (effort limitation) <p>Legal instrument:</p> <ul style="list-style-type: none"> Fisheries Law 1963 The Netherlands EU CFP Private law arrangements of groups of quota-holders <p>Bodies:</p> <ul style="list-style-type: none"> EU Netherlands Ministry of Agriculture, Nature and Food Regional Advisory Bodies (RAC) North sea Scientific Bodies: SPC 8 Fishermen's groups

7. Co-management: USA East Coast recreational and commercial fishery

1. SYSTEM	Co-management
2. STOCK	US East Coast recreational and commercial bluefish fishery
3. NEEDED INPUT DATA	<p>TAC setting:</p> <ul style="list-style-type: none"> • Catch-at-age/sex -environmental/habitat correlations • Sex and age structure • Market sampling programmes of landings and • Sampling programmes discards <p>TAC division:</p> <ul style="list-style-type: none"> • Relative stability EU • National ITQ holders • Share of national quota <p>Monitoring and Enforcement:</p> <ul style="list-style-type: none"> • Logbooks • Individualised quota landings • Quota management groups
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Catch at age • Effort : dealer databases and recreational surveys • Fisheries independent surveys
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Fmsy
6. FORECAST MODELS	<ul style="list-style-type: none"> • Variable: ICA and ASPIC and production models have been used depending on data available
7. SOFTWARE	
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • Atlantic States Marine Fisheries Commission • Mid-Atlantic Fisheries Management Council
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Dealer Databases • Recreational Fisheries surveys
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • Co-management, command and control <p>Tools:</p> <ul style="list-style-type: none"> • Size limits, • quotas <p>Legal instrument:</p> <ul style="list-style-type: none"> • Magnuson-Stevens Fisheries Act, various state laws. <p>Bodies:</p> <ul style="list-style-type: none"> • Atlantic Status Marine fisheries Comisión • Mid-Atlantic Fisheries Management Council

8. Financial instruments: USA Northeast ground fish fishery

1. SYSTEM	Financial instrument: Subsidy buyout programme (removed vessels no permits)
2. STOCK	<p>North East groundfish fishery (USA):</p> <ul style="list-style-type: none"> • 10 large mesh species (cod, haddock, yellowtail flounder, Pollock, witch flounder, American plaice, windowpane flounder, winter flounder, white hake, redfish) • 3 small mesh species (red hake, silver hake, ocean pout)
3. NEEDED INPUT DATA	<p>Fishing Fleet Data: (Costs and earnings data for economic concept of capacity not available)</p> <ul style="list-style-type: none"> • Vessels by gear type [trawlers, gillnetters, longline/jigging (hook)] • Fixed inputs per vessel (GRT, I, HWP) • Variable input per vessel (crew size) • Days at sea & fished days per vessel • Landings per vessel • Prices
4. ADVISORY/ANALYSIS TOOLS	<p>Estimates Fishing Fleet Capacity and Capacity Reduction:</p> <ul style="list-style-type: none"> • Data envelopment analysis (DEA) <p>[The Farrell's concept of Technical Efficiency (TE) is used through the construction of "best practice" frontier of observed maximum outputs given observed inputs]</p>
5. OUTPUT TO REFERENCE POINTS	<p>Selection of vessels:</p> <ul style="list-style-type: none"> • Lowest ratio • Owner's bid (willingness to sell price) /vessel's average annual revenue • Revenue used as proxy for capacity
6. FORECAST MODELS	
7. SOFTWARE	GAMS (Mathematical programming)
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • NOAA's National Marine Fisheries Service (NMFS), USA • Transboundary Resources Assessment Committee (TRAC)
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Northeast Fisheries Science Center (NEFSC- USA)
10. MANAGEMENT	<p>Means:</p> <p>Fishing activity of vessels constrained to rebuild stocks:</p> <ul style="list-style-type: none"> • Allocation of days at sea to each vessel (Non-transferable) • Closed areas (on both a year round and seasonal basis) • Moratorium on entry of new vessels into the fishery • Vessels only allowed a 1% upgrade in their physical characteristics (GT, HP and L) <p>Legal instrument:</p> <ul style="list-style-type: none"> • Amendments 5 & 7 to Northeast Multispecies Fishery Management plan (FMP) • USA-CANADA agreement <p>Bodies:</p> <ul style="list-style-type: none"> • USA-CANADA Transboundary Resources Assessment Committee (TRAC)

9. Financial instruments: Cod fishery in the Kattegat, Europe

1. SYSTEM	Variable tax rate on fish stock size (to eliminate free riding & solve the problem of illegal landings and discards within a total quota system)
2. STOCK	Cod fishery in the Kattegat (Denmark)
3. NEEDED INPUT DATA	<p>Biological stock data:</p> <p>(Assumption: Individual catches are unobservable due to illegal landings and discards. Stock size & costs are observable)</p> <ul style="list-style-type: none"> • Actual stock size x_t (at the end of each year) • Target stock size x^*_t (at the end of each year) • Total quotas • Natural growth function <p>Fishing Fleet Data:</p> <ul style="list-style-type: none"> • Vessels by gear type & GT [6 groups: 3 groups of Trawlers, 2 of Netters & 1 of Seiners] • Fixed and variable individual costs (per vessel group)
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Calibration cost function • Simulation (different rates of catch) • Sensitivity analysis (changes in cost parameters and functional forms)
5. OUTPUT TO REFERENCE POINTS	$T_{it}(x_{t+1}) = t_{it}(x^*_{t+1} - x_{t+1})$ <p>(Variable tax rates change between vessel groups)</p>
6. FORECAST MODELS	
7. SOFTWARE	
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • ICES (ACFM)
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • ICES (stock data) • Danish Directorate of Fisheries (landings data) • Institute of Food and Resource Economics (Cost and earnings data for the Danish fleet)
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC with quota system <p>Tools:</p> <p>Legal instrument:</p> <p>Bodies:</p> <ul style="list-style-type: none"> • EU • Denmark

10. Financial instruments: Iberian Atlantic hake fishery (southern hake)

1. SYSTEM	Financial instruments: Tax on effort
2. STOCK	Iberian-Atlantic hake Fishery (Southern stock)
3. NEEDED INPUT DATA	<p>Biological stock data:</p> <ul style="list-style-type: none"> • Stock • TAC • Catch <p>Fishing Fleet Data:</p> <ul style="list-style-type: none"> • Vessels by gear type [two groups: trawler fleet and the artisanal fleet] • Effort (fishing days) • Costs per unit of effort <p>Other economic data:</p> <ul style="list-style-type: none"> • Output price • Social discount rate
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Optimization techniques <ul style="list-style-type: none"> - Control variable: Fishing days - State variable: Fish population
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Optimum taxes per day: $T_i = \mu [\partial H_i (.)/\partial e_i]$
6. FORECAST MODELS	
7. SOFTWARE	
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • ICES assessment: WG on Southern Demersal Stock
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • ICES • IEO • COFRADIA OF CARIÑO
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC with quota system <p>Tools:</p> <p>Legal instrument:</p> <p>Bodies:</p> <ul style="list-style-type: none"> • EU • Spain • Portugal

11. Financial instruments: All Danish fisheries

1. SYSTEM	Financial instruments: Decommissioning
2. STOCK	All in the Danish fishery
3. NEEDED INPUT DATA	<p>Biological stock data:</p> <ul style="list-style-type: none"> • STOCK • TAC/ • Quota <p>Fishing Fleet Data:</p> <ul style="list-style-type: none"> • Vessels by length [22 groups] • Effort (sea days) • Catch per species/ vessel/day/area <p>Economic data</p> <ul style="list-style-type: none"> • Fish prices • Costs per sea day • Cost per vessels
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Optimization <ul style="list-style-type: none"> - Control variable: Number of vessels and sea days - State variable: Fish population
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Maximization of resource rent by fleet adjustment
6. FORECAST MODELS	<ul style="list-style-type: none"> • EMMFID • Comparative static model
7. SOFTWARE	<ul style="list-style-type: none"> • GAMS
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • ICES • Fish stock assessments
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • ICES: biological data • Institute of Food and Resource Economics: Cost and earnings data for the Danish fleet
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • Decommissioning subsidie <p>Tools:</p> <ul style="list-style-type: none"> • Capacity adjustment • Decommissioning <p>Legal instrument:</p> <ul style="list-style-type: none"> • Council Regulation 2371/2002 • Comisión Regulation 1438/2003 <p>Bodies:</p> <ul style="list-style-type: none"> • EU • Denmark

12. Command and control regimes: Bay of Biscay anchovy

1. SYSTEM	Command and control regimes
2. STOCK	Bay of Biscay anchovy
3. NEEDED INPUT DATA	<p>Biological stock data:</p> <ul style="list-style-type: none"> • Total catch in weight (by month) • Catch-at-age in numbers (by quarter) • Weight at age in the catch (by semester) • Length distribution in the catch (by quarter) <p>Direct research surveys:</p> <ul style="list-style-type: none"> • SSB and numbers at age estimates from DEPM • SSB and numbers at age estimates from ACOUSTICS • Weight at age in the stock
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • ICA • Biomass-based model
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Blim = Bloss
6. FORECAST MODELS	<ul style="list-style-type: none"> • MFDP • Projection from biomass-based model
7. SOFTWARE	<ul style="list-style-type: none"> • ICA • Biomass-based model implemented in Fortran
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • ICES (ACFM) • WGMHSA (Working Group on assessment on mackerel, horse mackerel, sardine and anchovy)
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • AZTI (Spain) • IEO (Spain) • IFREMER (France)
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC • Quota exchange between Spain and France <p>Tools: Not yet</p> <p>Legal instrument:</p> <ul style="list-style-type: none"> • Arcachon accord on transferring of quotas <p>Bodies:</p> <ul style="list-style-type: none"> • EU • Spain • France

13. Effort based management: Australian Northern prawn fisheries

1. SYSTEM	<ul style="list-style-type: none"> • Uni-jurisdictional capacity and license input-regulation-system • Management and restrictions on overall capacity licensed through statutory fishing property rights (SFR's) • Implemented as individual (private secure) and transferable vessel-based operation units, capacity units and fishing gear units defined partly from vessel size and engine power as well as fishing gear size and amount • Additionally managed through indirect input regulation with spatio-temporal closures and gear restrictions, as well as through by-catch and by-product regulations • Resources: Community property
2. STOCK	<ul style="list-style-type: none"> • Multi-species and Multi-fleet trawl fishery • Main target stocks of Tigre and Banana prawns with large amount of by-catch of a variety of by-catch species
3. NEEDED INPUT DATA	<ul style="list-style-type: none"> • Vessel capacity (vessel size and engine power time series) • Gear length by vessel (gear time series) • Effort (activity) per fleet in number of fishing days • Total weight of landings per target species (not by age) • Total weight of certain few by-catch species (not by age) • (Discards in weight for some species are sampled, however, not systematically. Accordingly, discard is not included in assessment) • Fleet based income and costs data • VMS data with respect to Compliance to regulations (e.g. closures)
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Single Species Surplus Production Models or Biomass Dynamics Models for target stocks (not by-catch stocks) calculating MSY (broken down to calculating of spawning stock, S(MSY), and effort E(MSY)) • Stock-Recruitment Models • Assessment of individual target species stocks • Bioeconomic assessment models of fleet economic efficiency by maximization of resource rent calculated as net return after Fishery and management costs (including behavioural algorithms) • No ecologically based assessment for the systems
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • MSY Reference Points broken down to calculation of spawning stock, S(MSY), and effort E(MSY)
6. FORECAST MODELS	<ul style="list-style-type: none"> • Risk analysis to assess probability that stocks are being fished at sustainable levels in relation to reference points
7. SOFTWARE	<ul style="list-style-type: none"> • Software and programs for Single Species Surplus Production Models

<p>8. ADVISORY BODIES / PROCEDURES</p>	<ul style="list-style-type: none"> • NPF Management Advisory Committee (NORMAC; with membership of AFMA management, science, industry/fishers, environment and conservation groups, as well as observers from province governments) • NPFAG (Northern Prawn Fishery Assessment Group; membership of fishery scientists and economists, AFMA management, conservation groups, NGO's, recreational fishing, state fisheries) • EA(Environment Comité; membership of AFMA management, science, industry, conservation groups, NGO's an the Commonwealth's Environment Agency (Environment Australia)
<p>9. ORIGIN OF DATA</p>	<ul style="list-style-type: none"> • AFMA (logbooks, annual data summary, landings originating from vessel owners and processors, gear sheets in logbooks, vessel inspection data, fishing license data) • CSIRO (reconciled landings time series, logbook time series, effort data, vessel and gear time series, research survey data, research data on species composition of catches)
<p>10. MANAGEMENT</p>	<p>Means:</p> <ul style="list-style-type: none"> • Shared, cooperative management • Fishing permits and licenses • Restrictions on overall capacity licensed through statutory fishing property rights (SFR's) • Managed with individual (private secure) and transferable vessel-based operation units (number of trawlers), capacity units (engine power, and ander-deck hull volume) and fishing gear units (size and amount of gear) • Additionally managed with indirect input regulation with spatio-temporal closures, restrictions on day-light trawling, and gear size restrictions, as well as through by-catch and by-product regulations (e.g. technical by-catch reduction devices on fishing gears, ban on take and retention of certain endangered species, or relative match limits of certain by-catch species). <p>Tools (HCR + strategies):</p> <ul style="list-style-type: none"> • Target MSY on single stock basis for target species as specific biologically based reference points for sustainable harvest of stocks • MSY is broken down into levels of spawning stock and fishing effort which produces maximum yields. • Objective of economic efficiency of fishery • Reduction of value of Statutory Fishing Rights • Objectives of reduction of overall fishing capacity and effort <p>Legal instruments</p> <ul style="list-style-type: none"> • Environment Protection Act (1974), and Environment Protection and Biodiversity Conservation (EPBC) Act (1999), as well as Commonwealths Guidelines for Ecologically Sustainable Management of Fisheries (2003), for protecting especially by-catch species • Fisheries Administration Act (1991) • Fisheries Management Act (1991)

	<ul style="list-style-type: none"> • NPF Management Plan (1995) • AFMA Directions • By-catch Action Plans, e.g. Commonwealth Policy on Fisheries By-catch (1995), or • Offshore Constitutional Settlement Agreement between Commonwealth and Queensland, the Northern Territory and Western Australia • Voluntary government ‘buy back’ schemes of capacity units and reduction in SFR value to reduce fleet capacity and number of licenses. • Compliance Plans through Service Level Agreements constituting a Compliance Program <p>Bodies</p> <ul style="list-style-type: none"> • AFMA (Australian Fisheries Management Authority) • Direct influence on Management and Advice from science, industry /fishers, environment and conservation groups, NGO’s, and boxers from province governments through NORMAC, NPFAG and EA
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14. Effort based management: Danish blue mussel fisheries, Europe

1. SYSTEM	<ul style="list-style-type: none"> • Effort and Capacity Based Fisheries Management • Entry restriction
2. STOCK	<ul style="list-style-type: none"> • Blue mussel
3. NEEDED INPUT DATA	<p>Biological stock data:</p> <ul style="list-style-type: none"> • STOCK • Quota <p>Fishing Fleet Data:</p> <ul style="list-style-type: none"> • Vessels by length [22 groups] • Effort (sea days) • Catch per species/ vessel/day/area <p>Economic data:</p> <ul style="list-style-type: none"> • Fish prices • Costs per sea day • Cost per vessels
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Stock size • Economic performance
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Resource rent
6. FORECAST MODELS	<ul style="list-style-type: none"> • Surveys
7. SOFTWARE	n/a
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • Danish Institute for Fisheries research (DIFRES) • Stock assessments
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • DIFRES (biological data) • Institute of Food and Resource Economics (FOI) • Cost and earnings data for the Danish fleet
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • Licenses • Restricted entry • Provisions for vessel characteristics <p>Tools:</p> <ul style="list-style-type: none"> • Capacity control <p>Legal instrument:</p> <ul style="list-style-type: none"> • National legal notices <p>Bodies:</p> <ul style="list-style-type: none"> • Denmark

15. Effort based management: Hake mixed fisheries, Europe

1. SYSTEM	Shared stock management (SSM)
2. STOCK	Hake stocks in the Mediterranean – based on GFCM division areas.
3. NEEDED INPUT DATA	<ul style="list-style-type: none"> • Catch in weight • Catch at age (numbers) • Weight at age (in the catch) • Proportion mature by age • Length composition in catch • Fleet capacity
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • FiSAT (FAO) • VIT
5. OUTPUT TO REFERENCE POINTS	n/a
6. FORECAST MODELS	n/a
7. SOFTWARE	<ul style="list-style-type: none"> • FAO_-FiSAT package • VIT
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • GFCM through SAC – Working group on demersal species
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • GFCM countries and/or various national Institutions
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • Fleet capacity regulation • Spatiotemporal fishery closures • Technical measures <p>Tools:</p> <ul style="list-style-type: none"> • Adaptive management <p>Legal instrument:</p> <ul style="list-style-type: none"> • CFP in the Mediterranean (only for EU waters) <p>Bodies:</p> <ul style="list-style-type: none"> • EU • GFCM

16. Effort based management: North Sea demersal fishery, Europe

1. SYSTEM	Effort and Capacity Based Fisheries Management
2. STOCK	North sea, Skagerrak, Kattegat and eastern channel Cod, haddock, whiting, saithe, plaice, sole, nephrops
3. NEEDED INPUT DATA	<p>Biological stock data:</p> <ul style="list-style-type: none"> • STOCK • TAC, fishing mortality <p>Fishing Fleet Data:</p> <ul style="list-style-type: none"> • Catch (age distribution of landings + discards) by fishery (60-100 demersal fisheries) by quarter. • Data on data quality (number of samples) • Effort (sea days) <p>Economic data:</p> <ul style="list-style-type: none"> • Value of landings
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • TAC and maximum number of sea days
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • Blim, Bpa, Fpa, • Catch (landings + discards) by fleet and fishery.
6. FORECAST MODELS	<ul style="list-style-type: none"> • MTAC (the ICES forecast model modified to account for mixed fisheries TAC)
7. SOFTWARE	<ul style="list-style-type: none"> • MTAC software (in R language). • Data base on catch (landings + discards) by fishery and data quality (number of samples).
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • STECF • STECF WG on Mixed fisheries. • STECF WG on effort management
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Output from ICES assessment and age distribution catch (landings and discards) data by fishery.
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC and maximum number of sea days <p>Tools:</p> <ul style="list-style-type: none"> • Catch and effort control <p>Legal instrument:</p> <ul style="list-style-type: none"> • EU regulations <p>Bodies:</p> <ul style="list-style-type: none"> • EU/Norway

17. Effort based management: Faroe Island - Multispecies fisheries, demersal stocks, Europe

1. SYSTEM	Effort system based on individual and tradable effort allocations. The system is characterized by a rigid fleet segmentation that regulates effort levels and the access to different fishing grounds. A modified set of rules is applied for regulating the artisan fleet segment.
2. STOCK	Multispecies fisheries targeting the demersal stocks on the Faroese shelf and on the Faroe Bank. Cod (two stocks), haddock, saithe.
3. NEEDED INPUT DATA	<p>Biological stock data:</p> <ul style="list-style-type: none"> • Catch at age, mean weight, maturity. • Two annual resource abundance surveys <p>Fishing Fleet Data:</p> <ul style="list-style-type: none"> • Commercial catch rate data worked up for a reference trawl fleet targeting Saithe to be used in the ICES assessment. • Various observations on catch rates, fish condition and stock distribution to be used by the Fishing day committee
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Single species sequential population analysis (VPA) tuned with either abundance survey information (cod, haddock) or commercial CPUE (saithe)
5. OUTPUT TO REFERENCE POINTS	SSB and F measures relevant for the standard ICES precautionary advisory approach (Blim, Bpa, Fpa and Flim)
6. FORECAST MODELS	<ul style="list-style-type: none"> • Single species Thompson and Bell forecast (main stream ICES approach)
7. SOFTWARE	<ul style="list-style-type: none"> • Mainly XSA. Occasionally supplemented with other VPA type models (e.g. adapt)
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • The Faroese Fisheries Laboratory bases its advise on the cooperation within ICES. ICES provides a standard stock assessment (North Western Working Group) that forms the technical basis for the ACFM advice. • The Fishing day Committee provides fisherman advice to the Ministry of fisheries. This advice is based on views and observation on effort levels, stock sizes, stock distributions etc.
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Faroese Fisheries Laboratory (biological data)
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • Licenses • Restrictions on fishing areas • Fishing day ceilings • Tradability of effort allocations between vessels <p>Tools:</p> <ul style="list-style-type: none"> • All vessels are distributed on fleet segments • Capacity Freeze within the fleet segments • A comprehensive system of area access rights for the individual fleet segments. • Effort ceilings for the individual fleet segments. • Rules regulating effort transfers within and between fleet segments. • The fisheries control keeps track of the individual vessel's usage of their effort allocation, including the effect of between vessels effort transfers. <p>Legal instrument:</p> <ul style="list-style-type: none"> • The effort system defined in a Fishing law. • The effort ceilings passed annually by parliament • Governmental orders fills out a number of technicalities. E.g. keys for converting fishing days between fleet segments.

	<p>Bodies:</p> <ul style="list-style-type: none">• The Faroese Ministry of Fisheries is responsible for regulating the fisheries. The fishing law stipulates that advice need be taken from the Faroese Fisheries Laboratory and from the Fishing Day committee.
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18. MSE: Orange roughy, Australia

1. SYSTEM	MSE
2. STOCK	Orange roughy in Australia
3. NEEDED INPUT DATA	<ul style="list-style-type: none"> • Catch in weight • CPUE • Egg survey • Trawl survey • Acoustics
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Bayesian assessment model based on CPUE for small stocks. • Bayesian assessment model based on relative acoustics, egg survey and biological parameters for eastern zones. • Assessment models used to explore alternative hypothesis for management objectives
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • B_{msy} • B_0 • $B_{current}/B_0$
6. FORECAST MODELS	
7. SOFTWARE	
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • Orange Roughy Assessment Group (ORAG) • South East Fishery Assessment Group (SEAG)
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Australia
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TACC • ITQs • Gear • restrictions • Area restriction <p>Tools:</p> <ul style="list-style-type: none"> • $B_{msy} = 30\%(B_0)$ <p>Legal instrument:</p> <ul style="list-style-type: none"> • Local fisheries legislation <p>Bodies:</p> <ul style="list-style-type: none"> • Australian Fisheries Management Agency (AFMA)

19. MSE: Blue eye trevalla, Australia

1. SYSTEM	MSE
2. STOCK	Blue eye trevalla, Australia
3. NEEDED INPUT DATA	
4. ADVISORY/ANALYSIS TOOLS	
5. OUTPUT TO REFERENCE POINTS	$B_{SS} \geq B_{1984}$
6. FORECAST MODELS	
7. SOFTWARE	
8. ADVISORY BODIES / PROCEDURES	
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Australia
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC • ITQs • By catch quotas <p>Tools:</p> <ul style="list-style-type: none"> • Not yet defined <p>Legal instrument:</p> <ul style="list-style-type: none"> • Local fisheries legislation <p>Bodies:</p> <ul style="list-style-type: none"> • Australian Fisheries Management Agency (AFMA)

20. MSE-OMP: Southern Blue Fin Tuna (SBT), Pacific

1. SYSTEM	Forthcoming OMP/Shared stocks
2. STOCK	Southern Blue Fin Tuna (SBT) (<i>Thunnus macoyii</i>), Pacific
3. NEEDED INPUT DATA	<ul style="list-style-type: none"> • Total catch in weight • Catch at size • Catch at age • CPUE data • Scientific Observer Programme
4. ADVISORY/ANALYSIS TOOLS	
5. OUTPUT TO REFERENCE POINTS	<ul style="list-style-type: none"> • SSB_{1984} used as a baseline, e.g: $SSB_{2000} / SSB_{1984} = 0.14-0.33$
6. FORECAST MODELS	<ul style="list-style-type: none"> • CCSBT Operating model
7. SOFTWARE	
8. ADVISORY BODIES / PROCEDURES	<p>CCSBT:</p> <ul style="list-style-type: none"> • Stock assessment group (SAG) • Scientific committee (SC)
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Member states cooperative non-members • Japanese statistical service • Trade Information Scheme (TIS)
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC for the CCSBT members: Japan, Australia, Republic of Korea, Chinese Taipei, New Zealand • Additional TAC for cooperative non members: Philippines and Indonesia <p>Tools:</p> <ul style="list-style-type: none"> • Management Procedure (MP) (forthcoming) <p>Legal instrument:</p> <ul style="list-style-type: none"> • Convention for the Conservation of the Southern Bluefin Tuna (1993) • Trade Information Scheme (TIS) <p>Bodies:</p> <ul style="list-style-type: none"> • CCSBT

21. Joint Management Procedure: South African pelagic species

1. SYSTEM	Joint Management Procedure
2. STOCK	<ul style="list-style-type: none"> • Sardine • Anchovy
3. NEEDED INPUT DATA	<p>Sardine:</p> <ul style="list-style-type: none"> • Two surveys (Acoustic adult, Acoustic juvenile) with sampling CVs • Proportion-at-age from acoustic adult survey • Catch-at-age <p>Anchovy:</p> <ul style="list-style-type: none"> • Three surveys (DEPM, Acoustic adult, Acoustic juvenile) with sampling CVs • Proportion of 1-year olds in acoustic adult survey • Age-structured catch data (assumed without error)
4. ADVISORY/ANALYSIS TOOLS	<ul style="list-style-type: none"> • Age-structured population model, based on maximum likelihood estimation • Management Procedure Evaluation Framework
5. OUTPUT TO REFERENCE POINTS	<p>Sardine:</p> <ul style="list-style-type: none"> • Risk of collapse (probability $SSB < 0.2K$; probability of $SSB < \text{average } SSB$ during period of low abundance) • Depletion level (SSB/K, and SSB future relative to SSB current) <p>Anchovy:</p> <ul style="list-style-type: none"> • Risk of collapse (probability $SSB < 0.15K$) • Depletion level (SSB/K, and SSB future relative to SSB current)
6. FORECAST MODELS	<ul style="list-style-type: none"> • OMP simulations, with a projection period of 20 years
7. SOFTWARE	<ul style="list-style-type: none"> • Custom-made software
8. ADVISORY BODIES / PROCEDURES	<ul style="list-style-type: none"> • SA Government • Scientific-Industry Fora • Scientific Working Groups
9. ORIGIN OF DATA	<ul style="list-style-type: none"> • Logbooks • Port sampling • Observer schemes • Scientific surveys
10. MANAGEMENT	<p>Means:</p> <ul style="list-style-type: none"> • TAC and total allowable bycatch • Fishing rights • Fishing permits • Fisheries regulations <p>Tools:</p> <ul style="list-style-type: none"> • OMPs evaluated by simulation and presented at Scientific Working Groups and Scientific-Industry Fora <p>Legal instrument:</p> <ul style="list-style-type: none"> • Marine Living Resources Act <p>Bodies:</p> <ul style="list-style-type: none"> • South African Government, Marine and Coastal Management