

## **DESCRIPTION OF THE BIOECONOMIC MODEL ISIS-Fish V2.0**

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ISIS-Fish V2.0 includes economic considerations and additional features regarding fishing activities. The population model has not been changed, but for a few attributes (e.g. species price). The description of fishing activity has been modified to accommodate calculations of costs and earnings (Figure 1, Tables 1 to 3).

Main changes are :

- Travel time to fishing grounds are precisely calculated from the relative locations of ports and métier zones.
- Technical characteristics of vessels are included in the model in that they lead to different crew sizes, possible trip duration.
- Several parameters describing métier effort have been made dependent on vessel type.
- Strategies can change trip duration from one month to the other and there is a monthly number of inactivity days, allowing to account for possible periods of low activity.

From a programming standpoint, matrix calculations of fishing effort and fishing mortalities have been replaced by functional calculations.

Fishers' behaviour with respect to the fisheries context, either economic or not, may be considered via an optimization model (not yet coded), a gravity model, or through other decision rules.

Optimization : Two solutions are envisaged : a) use of a Java subroutine called by a Script language within ISIS ; b) coupling of ISIS-Fish with an IBM model depicting short-term individual behaviour of fishers.

Gravity model : The gravity model will be coded in Script language considering several cases (Table 4).

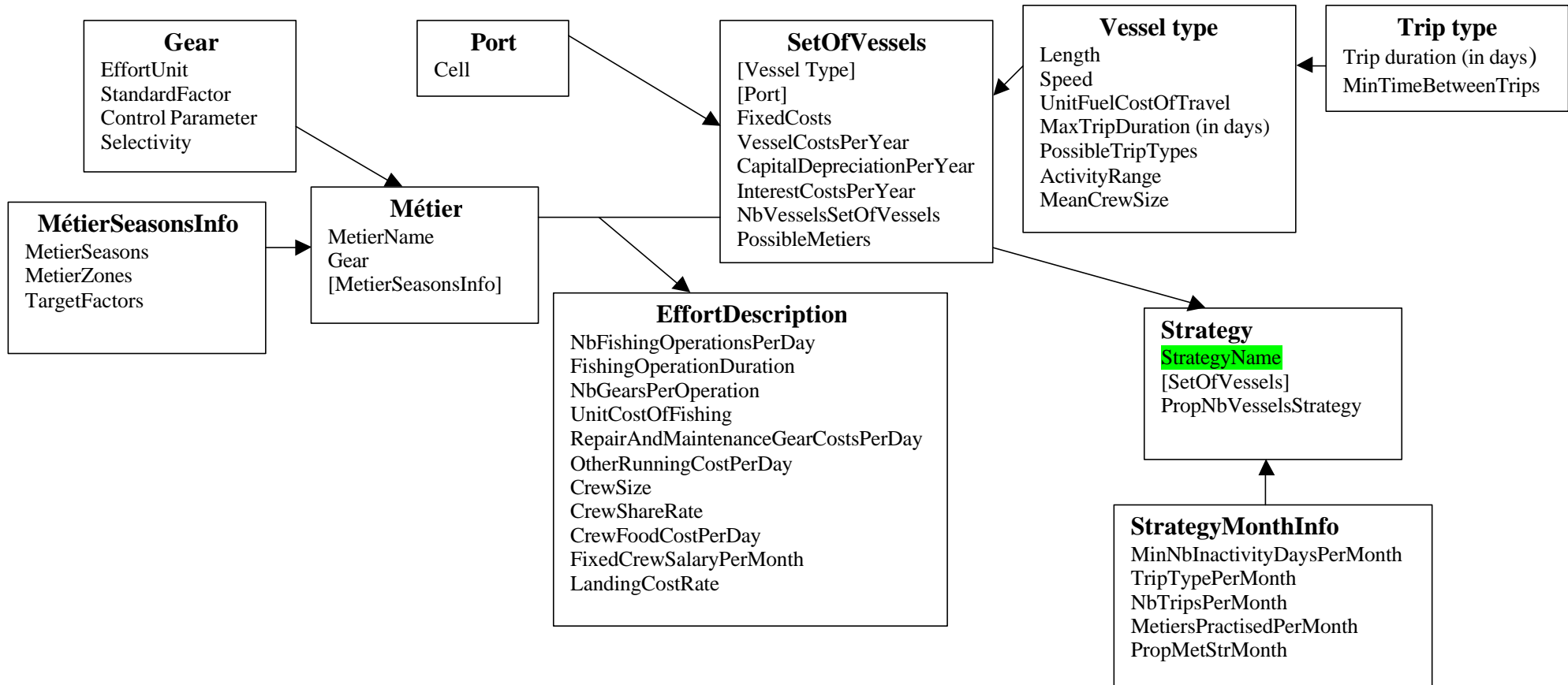


Figure 1. Description of model objects in ISIS-Fish V2.0. Brackets surround parameters that are not real attributes of the object (they may be objects linked with the current object), but are mentioned as a reminder.

**Vessel type**

This object depicts vessel types as a function of their physical and technical characteristics.  
 PossibleTripTypes is calculated as a function of MaxTripDuration (TripTypes have been input previously)  
 ActivityRange is not used yet. It should be used to determine PossibleTripTypes.  
 MinCrewSize is the minimum crew size on this type of vessel.  
 UnitFuelCostOfTravel is the cost in fuel per hour (in euros) of travel.

**SetOfVessels**

This object describes sets of vessels that have the same vessel type and come from a given port.

FixedCosts are the (coûts fixes décaissés ?)

VesselCostsPerYear are the coûts fixes (lien avec fixed costs?) par mois ? par année ?

CapitalDepreciationPerYear amortissement

InterestCostsPerYear frais financiers

PossibleMetiers describes the potential métiers used by a set of vessels.

**EffortDescription**

This object is an association class between SetOfVessels and Metier. It depicts for each set of vessels the effort characteristics tied to a given metier.

FishingOperationDuration is not used yet in the equations. Interest ?

NbGearsPerOperation is not used yet in the cost equations.

CrewFoodCostPerDay is the cost of food for the crew per day. It is not used yet in the equations.

FixedCrewSalaryPerMonth is the fixed part of the monthly salary for the whole crew. It is not used yet in the equations.

**StrategyMonthInfo**

This object depicts the seasonality of fishing activities in a given strategy and the description of the behaviours that can alter fishing activities.

MinNbInactivityDaysPerMonth allows to consider monthly variations in overall activity

TripTypePerMonth is the trip type actually used at a given month by vessels in the strategy. Only one trip type is used per month.

NbTripsPerMonth must be consistent with PossibleTripTypes and MinNbInactivityDaysPerMonth

MetiersPractisedPerMonth is not used up to now.

PropMetStrMonth is the proportion of vessels practising a metier during a month in a given strategy. In the effort model, the proportion of vessels practising a metier each month is equivalent to the proportion of effort allocated by each vessel to a given metier at a given month.

StrategyBehaviour includes the behaviour of the strategy, i.e. decision rules and models modifying the structural allocation of fishing effort described by Strategy and EffortDescription. It includes the gravity model and the optimisation module, that may be used or not, depending on simulations.

**Attributes to change in existing objects****PopulationClass**

add PricePerKg

**Gear**

add GearCost is the cost of buying the gear. Usure is ignored.

**Metier**

remove the attributes that depend now on SetOfVessels and put them in EffortDescription.

**Strategy**

Name of Strategy

PropNbVesselsStrategy applies to NbVesselsSetOfVessels

Table 1. Notations used in the equations.

CapitalDepreciationPerYear[sov]	Yearly amortissement of a vessel of set of vessel sov
cl	a given population class
CrewShareRate[sov,met]	Crew share rate for a vessel of set of vessel sov practising métier met (taux de part de l'équipage)
CrewSize[sov,met]	Crew size for a vessel of set of vessel sov practising métier met
DiscardsPerStrategyMet[str,met,pop,cl,zpop]	Discards of class cl of pop in zone pop resulting from vessels of Strategy str practising métier met
gear	a given gear
FixedCostsPerMonth[sov]	Fixed costs per month for a vessel of set of vessel sov
InterestCostsPerYear[sov]	Interest costs of a vessel of set of vessel sov
LandingCostRate[str,met]	Landing cost rate linked to métier met in the port of strategy str
MinCrewSize[sov]	Minimum crew size for a vessel of vessel type sov
MinNbInactivityDaysPerMonth[str,month]	Minimum Number of Inactivity Days Per Month for Strategy str
month	a given month
MonthDuration[month]	Duration of each month
NaturalMortality[pop,cl]	Annual coefficient of natural mortality for class cl of population pop
NbFishingOperationsPerDay[sov,met]	Number of fishing operations per fishing day for a vessel from the set of vessels sov when practising métier met
NbGearsPerOperation[sov,met]	Number of gears used per fishing operation for a vessel from the set of vessels sov when practising métier met
NbMetiers	Number of metiers in the fishery
NbSetOfVessels	Number of sets of vessels in the fishery
NbStrategies	Number of strategies in the fishery
NbVesselsSetOfVessels[sov]	Number of vessels in set of vessels sov
NbZMetiers	Number of métier zones in the fishery
OtherRunningCostsPerDay[sov,met]	need a definition of these costs for a vessel from the set of vessels sov when practising métier met
pop	a given population
port	a given port
PropNbVessels[str]	Proportion of vessels of the SetOfVessels that are in Strategy str
PropMetStrMonth[str,met,month]	Proportion of vessels of strategy str that practice métier met at month
q[pop,cl,zpop,month]	Catchability coefficient of class cl of population for month
RepairAndMaintenanceGearCostsPerDay[sov,met]	Repair and maintenance costs per fishing day for a vessel of set of vessel sov practising métier met
Sel[gear,pop,longueur(cl)]	Selectivity of gear for class cl of population
sov	a given set of vessels
Speed[sov]	Average speed of a vessel from SetOfVessels sov
StandardFactor[gear[met]]	Effort standardisation factor for gear used by métier met
str	a given strategy
TargetFactor[met,pop,month]	Target Factor of métier met for population at month
TriptypePerMonth[str,month]	Trip Type of str at month month
TripDuration[TripType[str]]	Trip Duration of TripType corresponding to strategy str
UnitCostsOfFishing[sov,met]	Fuel, oil and ice costs per fishing operation for a vessel of set of vessel sov practising métier met
UnitFuelCostOfTravel[vt]	Fuel and oil cost per hour of travel for a vessel of type vt

VesselCostsPerYear[ <i>sov</i> ]	coûts fixes (lien avec fixed costs?) par mois ? par année ? of a vessel of set of vessel <i>sov</i>
<i>vt</i>	a given vessel type
<i>zmet</i>	a given metier zone
<i>zpop</i>	a given population zone

en vert : changements pour Benjamin

en bleu : nécessite clarifications de la part des Oliviers

Table 2. Equations used to compute fishing mortality, catch and resulting abundance from effort description.

Equation	Type and dimension
<p>DistancePortZmet[port,zmet]=Average Distance between each port and each cell of zmet            The distance between the centres x1 and x2 of two cells (in km) writes : <math>Dkm(x1,x2) &lt;- Rearth * acos(sin(lat[x1]/p)*sin(lat[x2]/p) + (cos(lat[x1]/p) * cos(lat[x2]/p)*cos(lon[x1]/p - lon[x2]/p)))</math> où <math>p &lt;- 180/pi</math>; Rearth (in km) &lt;- 6378.388</p>	Matrice NbPorts X NbZmetier calculée une fois par simulation
<p>TravelTimePerTrip[sov,met,month]= 2* DistancePortZmet[port[sov],zmet] / Speed[sov] is the travel time to metier zone zmet for a vessel of the SetOfVessel sov. TravelTimePerTrip is expressed in hours.</p>	Matrice NbSetOfVessels X NbZMetier calculée une fois par simulation et si zmet change sous l'effet d'une mesure de gestion
<p>The fishing time per trip of a vessel of Strategy str that practices metier met at month month<sup>1</sup> is            FishingTimePerTrip[str,met,month]= NbHoursPerDay * TripDuration[TripTypePerMonth[str,month]] – TravelTimePerTrip[sov,met,month] , where NbHoursPerDay is 24 h.d<sup>-1</sup>            FishingTimePerTrip is expressed in hours.</p>	Matrice NbStrategies X NbMetier X 12 calculée une fois par simulation et si TripType change sous l'effet d'un comportement
<p>For each strategy and each month,            NbTripsPerMonth[str,month] = Int{ (MonthDuration[month] – MinNbInactivityDaysPerMonth[month])/TripDuration[Triptype[str,month]] }<sup>2</sup>            NbInactivityDaysPerMonth[str,month] = MonthDuration[month] – NbTripsPerMonth[str,month]</p>	Entiers rattachés à StrategyMonthInfo calculés une fois par simulation , et recalculée si TripType change sous l'effet d'un comportement
<p>For each set of vessels sov and each metier met,            StdEffortPerHour[sov,met]= StandardFactor[gear[met]]NbFishingOperationsPerDay[sov,met]NbGearsPerOperation[sov,met]/NbHoursPerDay            StdEffortPerHour(sov,met) =  <math display="block">F_{std} ( gear ( met ) ) NbFishingOperationsPerDay ( sov,met ) NbGearsPerOperation ( sov,met ) / NbHoursPerDay</math>            StdEffortPerHour is expressed in standard unit of effort per hour.</p>	Matrice NbSetOfVessels X NbMetiers calculée une fois par simulation (si les données ne changent pas)
<p>For each strategy str and each metier met,            EffortPerStrategyPerVessel[str,met,month]= NbTripsPerMonth[str,month]            FishingTimePerTrip[str,met,month]StdEffortPerHour[sov(str),met] where sov is the SetOfVessels corresponding to Strategy str  <math display="block">EffortPerStrategyPerVessel ( str,met,month ) =</math>  <math display="block">NbTripsPerMonth ( str,month ) FishingTimePerTrip ( str,met,month ) StdEffortPerHour ( sov,met )</math>            EffortPerStrategyPerVessel[str,met,month] is in standard units of effort for a month.            Similarly, we calculate the total travel time per month per vessel for the metier in the strategy :  <math display="block">StdTravelEffortPerVessel ( str,met,month ) = TravelTimePerTrip ( sov,met ) NbTripsPerMonth ( str,month ) StdEffortPerH</math></p>	
For each strategy str and each metier met,	Matrice NbStrategies X NbMetier X 12

<sup>1</sup> Csq : Si un navire doit changer de durée de marée en cours de simulation, cela se fera par un changement de stratégie

<sup>2</sup> On aurait pu en faire un réel, mais cela pose le problème que les temps de trajet seront aussi proratisés et du coup, cela n'aura plus de sens car pour aller sur une zmet donnée, il y aura moins de temps de trajet qu'il ne faut. Si on imagine que la marée se finit sur le mois suivant, on retombe sur nos pattes, mais ce n'est pas garanti.

<p>EffortPerStrategyMet[<i>str,met,month</i>]=  <math>\text{PropNbVessels}[str,sov] \text{NbVesselsSetOfVessels}[sov] \text{PropMetStrMonth}[str,met,month] \text{EffortPerVessel}[str,met,month]</math>  <math>\text{EffortPerStrategyMet}(str,met,month) =</math>  <math>\text{PropNbVessels}(str,sov) \text{NbVessels}(sov) \text{PropMetStrMonth}(str,met,month) \text{EffortPerStrategyPerVessel}(str,met,month)</math></p> <p>Similarly, we calculate the total travel time per month for the metier in the strategy :</p> $\text{StdTravelEffortPerStrategyMet}(str,met,month) =$ $\text{PropNbVessels}(str,sov) \text{NbVesselsSetOfVessels}(sov) \text{PropMetStrMonth}(str,met,month) \text{StdTravelEffortPerVessel}(str,met,month)$	<p>calculés pour chaque mois une fois par simulation , et recalculée si TripType, PropNbVessels, PropMetStrMonth changent sous l'effet d'un comportement</p> <p><b>RESULTAT</b></p>
<p>For each strategy <i>str</i> and each metier <i>met</i>,  <math>\text{EffortPerStrategyPerCell}[str,met,month] = \text{EffortPerStrategy}[str,met,month] / \text{NbCells}[zmet(met)]</math></p>	
<p>For each strategy <i>str</i>, each metier <i>met</i> and each population <i>pop</i> caught by the metier  <math>\text{EffortPerStrategyPerZpop}[str,met,month,zpop] = \text{EffortPerStrategyPerCell}[str,met,month] \text{NbCells}[\text{Intersection}(zpop,zmet)]</math></p> $\text{EffortPerStrategyPerZpop}(str,met,month,zpop) = \text{EffortPerStrategyPerCell}(str,met,month) \text{NbCells}(zpop \cap zmet)$	<p>Matrice NbStrategies X NbMetier X 12 calculés pour chaque mois une fois par simulation, et recalculée si TripType, PropNbVessels, PropMetStrMonth changent sous l'effet d'un comportement</p> <p><b>RESULTAT</b></p>
<p>For each strategy <i>str</i>, each metier <i>met</i>, each population <i>pop</i> caught by the metier, each population zone <i>zpop</i> and each class <i>cl</i>  <math>\text{FishingMortality}[str,met,month,pop,zpop,cl] =</math>  <math>\text{Sel}[gear,pop,longueur(cl)] q[pop,cl,zpop,month] \text{TargetFactor}[met,pop,month] \text{EffortPerStrategyPerZpop}[str,met,month,zpop]</math>  <math>\text{FishingMortality}(str,met,month,pop,zpop,cl) =</math>  <math>\text{Sel}(gear,pop,cl) q(pop,cl,zpop,month) \text{TargetFactor}(met,pop,month) \text{EffortPerStrategyPerZpop}(str,met,pop,zpop)</math></p> <p>For each population <i>pop</i> caught by the metier, each population zone <i>zpop</i> and each class <i>cl</i>  <math>\text{TotalFishingMortality}[month,pop,zpop,cl] = \text{Sum over strategies and metiers FishingMortality}[str,met,month,pop,zpop,cl]</math></p>	<p>Pour chaque classe de chaque population capturée par le métier,  Matrice NbStrategies X NbMetier X 12 X NbClassPop X NbZpop(pop)</p>
<p>For each population <i>pop</i> caught by the metier, each population zone <i>zpop</i> and each class <i>cl</i>  <math>\text{TotalCatchRate}[month,pop,zpop,cl] = F / (F+M) \{ 1 - \exp(-(F+M)) \}</math> where <math>F = \text{TotalFishingMortality}[month,pop,zpop,cl]</math> and <math>M = \text{NaturalMortality}[pop,cl] / 12</math></p> <p>Catch per strategy and metier is calculated as :</p> $\text{CatchRatePerStrategyMet}[str,met,month,pop,zpop,cl] = \{ \text{FishingMortality}[str,met,month,pop,zpop,cl] / \text{TotalFishingMortality}[month,pop,zpop,cl] \} * \text{TotalCatchRate}[month,pop,zpop,cl]$ $\text{CatchPerStrategyMet}[str,met,month,pop,zpop,cl] = \text{CatchRatePerStrategyMet}[str,met,month,pop,zpop,cl] \text{Abundance}[pop,cl,zpop,month]$ where Abundance[] is calculated after change of class, migration , reproduction and recruitment $\text{CatchWeightPerStrategyMet}[str,met,month,pop,zpop,cl] = \text{CatchPerStrategyMet}[str,met,month,pop,zpop,cl] * \text{MeanWeight}[pop,zpop,cl]$	<p>Pour chaque classe de chaque population capturée par le métier,  Matrice NbStrategies X NbMetier X 12 X NbClassPop X NbZpop(pop)</p>

DiscardsWeightPerStrategyMet has to be calculated if necessary : DiscardsWeightPerStrategyMet[ <i>str,met,pop,cl,zpop</i> ] = CatchWeightPerStrategyMet[ <i>str,met,month,pop,zpop,cl</i> ]	<b>RESULTAT</b> : CatchPerStrategyMet et Abundance en début de pas de temps
Abundance at <i>month+1</i> is calculated as : SurvivalRate[ <i>pop,cl,zpop,month</i> ] = exp(-(F+M)) where F= TotalFishingMortality[ <i>month,pop,zpop,cl</i> ] and M = NaturalMortality[ <i>pop,cl</i> ]/12 Abundance[ <i>pop,cl,zpop, month+1</i> ] = SurvivalRate[ <i>pop,cl,zpop,month</i> ] Abundance[ <i>pop,cl,zpop,month</i> ] where Abundance[] is calculated after change of class, migration , reproduction and recruitment Biomass [ <i>pop,cl,zpop, month+1</i> ] = Abundance[ <i>pop,cl,zpop, month+1</i> ]	<b>RESULTAT</b> : CatchWeight, Biomass

NbTripsPerMonth is an attribute of StrategyMonthInfo. It is calculated for each strategy and each month, once the strategy has been input.  
Everything that depends on month indeed depends on metier season, but for consistency accross metiers, the common denominator is the month

Table 3. Equations used to compute costs and revenues.

Cost equations	Type and dimension
FishingTimePerMonth[ <i>str,met,month</i> ] = FishingTimePerTrip[ <i>str,met,month</i> ]NbTripsPerMonth[ <i>str,month</i> ] FuelCostsOfTravel[ <i>sov,met,month</i> ] = NbTripsPerMonth[ <i>str,month</i> ]*TravelTimePerTrip[ <i>sov,met,month</i> ]*UnitFuelCostsOfTravel[ <i>vt</i> ] CostsOfFishing[ <i>str,met,month</i> ]= FishingTimePerMonth[ <i>str,met,month</i> ] {NbFishingOperationsPerDay[ <i>sov,met</i> ] UnitCostsOfFishing[ <i>sov,met</i> ] / 24} FuelCosts[ <i>str,met,month</i> ] = FuelCostsOfTravel[ <i>sov,met,month</i> ] + CostsOfFishing[ <i>str,met,month</i> ]  RepairAndMaintenanceGearCosts[ <i>str,met,month</i> ] = FishingTimePerMonth[ <i>str,met,month</i> ] *RepairAndMaintenanceGearCostsPerDay[ <i>sov,met</i> ]/NbHoursPerDay OtherRunningCosts[ <i>str,met,month</i> ]= FishingTimePerMonth[ <i>str,met,month</i> ]*OtherRunningCostsPerDay[ <i>sov,met</i> ]/ NbHoursPerDay SharedCosts[ <i>str,met,month</i> ]= FuelCosts[ <i>str,met,month</i> ] + OtherRunningCosts[ <i>str,met,month</i> ] + FixedCostsPerMonth[ <i>sov</i> ] <b>VesselCostPerYear non pris en compte : quelle équation ?</b>	<b>RESULTATS</b>
Revenues equations	
For each métier <i>met</i> and each strategy <i>str</i> , GrossValueOfLandingsPerSpeciesPerStrategyMet[ <i>str,met,pop,month</i> ] = sum over classes_cl of [PricePerKg( <i>pop,cl</i> , t)* (CatchWeightPerStrategyMet [ <i>str,met,pop,cl,month</i> ] –DiscardsWeightPerStrategyMet [ <i>str,met,pop,cl,month</i> ]  NetValueOfLandings[ <i>str,met,pop,month</i> ] = GrossValueOfLandingsInStrategy[ <i>str,met,month</i> ] (1- <b>LandingCostRate</b> [ <i>str,met</i> ])  NetRevenueToShare[ <i>str,met,month</i> ] = NetValueOfLandings[ <i>str,met,pop,month</i> ] - SharedCosts[ <i>str,met,month</i> ] CrewShare[ <i>str,met,month</i> ] = NetRevenueToShare[ <i>str,met,month</i> ]*CrewShareRate[ <i>sov,met</i> ]* <b>CrewSize</b> [ <i>sov,met</i> ] OwnerMarginOverVariableCosts[ <i>str,met,month</i> ] = NetRevenueToShare[ <i>str,met,month</i> ] -CrewShare[ <i>str,met,month</i> ] - RepairAndMaintenanceGearCosts[ <i>str,met,month</i> ] VesselMarginOverVariableCosts [ <i>str,met,month</i> ] = NetRevenueToShare[ <i>str,met,month</i> ]-RepairAndMaintenanceGearCosts[ <i>str,met,month</i> ]  OwnerMarginOverVariableCosts [ <i>str,month</i> ] = somme sur métiers de OwnerMarginOverVariableCosts[ <i>str,met,month</i> ] VesselMarginOverVariableCosts [ <i>str,month</i> ] = somme sur métiers de VesselMarginOverVariableCosts [ <i>str,met,month</i> ]	<b>RESULTATS</b> dans les visualisations, on fera les sommes qu'on veut (sur pop, sur metiers, etc...)

For each year, economic indicators can be calculated : GrossMargin[ <i>str,year</i> ] = Sum over months OwnerMarginOverVariableCosts[ <i>str,month</i> ]-VesselCostsPerYear[ <i>sov</i> ] FullEquityProfit[ <i>str,year</i> ] = GrossMargin[ <i>str,year</i> ] – CapitalDepreciationPerYear[ <i>sov</i> ] NetProfit[ <i>str,year</i> ] = FullEquityProfit[ <i>str,year</i> ] - InterestCostsPerYear[ <i>sov</i> ]	
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Table 4. Equations for effort dynamics (gravity model in a first step). Attractivity will be coded for each of the following cases.

Attractivity based on LPUE	$LandingPerUnitFishingEffort(str,met,t(y-1)) = \frac{\sum_{popclasses\_cl} \sum_{zpop(pop)} \left[ \sum \left\{ CatchWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) - DiscardsWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) \right\} \right]}{EffortPerStrategyMet(str,met,t(y-1))}$
Attractivity based on LPUE including also TravelTime	$LandingPerUnitTotalEffort(str,met,t(y-1)) = \frac{\sum_{popclasses\_cl} \sum_{zpop(pop)} \left[ \sum \left\{ CatchWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) - DiscardsWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) \right\} \right]}{EffortPerStrategyMet(str,met,t(y-1)) + StdTravelEffortPerStrategyMet(str,met,t(y-1))}$
Attractivity based on VPUE	$ValuePerUnitFishingEffort(str,met,t(y-1)) = \frac{\sum_{popclasses\_cl} \sum_{zpop(pop)} \left[ Pr \sum \left\{ CatchWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) - DiscardsWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) \right\} \right]}{EffortPerStrategyMet(str,met,t(y-1))}$ where Pr = PricePerKg( <i>pop,cl</i> )
Attractivity based on VPUE including also TravelTime	$ValuePerUnitTotalEffort(str,met,t(y-1)) = \frac{\sum_{popclasses\_cl} \sum_{zpop(pop)} Pr \left[ \sum \left\{ CatchWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) - DiscardsWeightPerStrategyMet(str,met,pop,zpop,t(y-1),cl) \right\} \right]}{EffortPerStrategyMet(str,met,t(y-1)) + StdTravelEffortPerStrategyMet(str,met,t(y-1))}$ where Pr = PricePerKg( <i>pop,cl</i> )
Attractivity based on owner margin over variable costs	$OwnerMarginOverVarCosts(str,met,t) = \sum_{metiers} \left\{ \begin{array}{l} NetRevenueToShare(str,met,month) \\ -CrewShare(str,met,month) - RepairAndMaintenanceCosts(str,met,month) \end{array} \right\}$
Attractivity based on vessel margin over variable costs	$OwnerMarginOverVarCosts(str,met,t) = \sum_{metiers} \left\{ \begin{array}{l} NetRevenueToShare(str,met,month) \\ -RepairAndMaintenanceCosts(str,met,month) \end{array} \right\}$

LPUE, VPUE and margins are calculated each time they are used in the gravity model. The gravity model is coded in Javascript and uses different versions of these variables.

## Modelling the impact of management measures and economic conditions on fishing effort.

Fishers behaviour in reaction to either a management scenario or to economic conditions in the fishery may alter fishing effort in different ways.

Fishers' behaviour	Model parameter affected	Level in the model	Constraints
Fishers shorten or lengthen trip duration.	TripTypePerMonth and consequently NbTripsPerMonth and NbInactivityDaysPerMonth		TripType is constant in a given month. It can only change from one month to the other It must be consistent with PossibleTripTypes
Fishers change the number of inactivity days per month	MinNbInactivityDaysPerMonth	Strategy	
Fishers change metiers within a given strategy	PropMetStrMonth		
Fishers change strategies within a given set of vessels	PropNbVesselsStrategy		Fishers cannot change set of vessels

Allocation of fishing effort between metiers is the main behaviour contemplated up to now. This includes the choice of either a gear, fishing zones, or target species.

## Modelling the impact of technological and tactical changes on fishing effort.

Fishing effort may be altered in different ways.

Change	Model parameter potentially affected	Level in the model
Vessel efficiency (physical characteristics)	Speed MaxTripDuration	VesselType
Vessel efficiency (physical characteristics)	NbFishingOperationsPerDay NbGearsPerOperation	EffortDescription
Gear efficiency	StandardFactor	Gear
Gear selectivity	Selectivity	Gear
Fishing power of vessels in the same strategy (same kind of fishing activities)	NA now	Strategy
Fishing power on a given metier	TargetFactor	Métier