

# Forecasting with FLR - an introduction to FLash



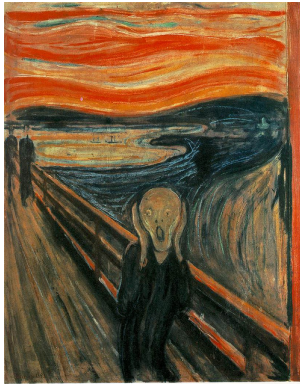
FISHREG  
Maritime Affairs Unit - IPSC  
European Commission  
Joint Research Center

## Flash!



Ahhhhhhhh!

# FLash!



Agggggghhh!

## Performing projections

Why?

- Predict the future
- Understand potential consequences of management actions

Results depend on many, many assumptions

## Performing projections

Things to consider:

- Time scale - 3 years? 5? 20?
- Stock biology - growth and recruitment?
- Incorporate uncertainty
- Model the management scenario

Again: Results depend on many, many assumptions

## The importance of $F$

Management can have many aims.  
To achieve these aims it sets targets:

- Effort
- Catch (Landings or Discards)
- Biomass (SSB)
- Economic (Revenue)

To hit these targets all we can really control is the fishing mortality,  $F$

## Introducing `fwd()`

`fwd()` is the engine of projection in FLR

Can be easy to set up - just need to combine the right components

Very easy to get wrong

Success tastes great!

## Cake



Making a cake requires combining several ingredients

Some cakes are more difficult to make than others

Can go badly wrong

Success tastes great!

`fwd() = cake`



## Basic ingredients

- Stock to be projected
- Stock-recruitment relationship
- Projection control (set targets)

## The stock

Obviously, this means an FLStock

- Need to set up the stock 'future'
- Requires assumptions to be made, e.g. future stock weights, natural mortality etc.
- `stf()`

A simple example. . .

## The control object

- `fwdControl`
- Set target type and value for each year of the projection
- Can have multiple targets
- Can include bounds on the targets (min and max)
- Target values can be relative
- Target values can have multiple iterations (stochasticity)
- Can be complicated. . .

But it does not have to be complicated.  
Sometimes, the simplest things are the tastiest. . .

## Recipe 1 - Flapjack



Setting  $F$  as a target

## Recipe 2 - Welsh cake



Setting Catch as a target

Other target types include:

F, SSB, Landings, Discards, Z, Effort, Costs, Revenue. . .

## Recipe 3 - Muffin (blueberry)



SSB as a target

Be careful with timing:

The target year is the year that  $F$  is set

SSB in year  $Y$  is a result of  $F$  in year  $Y-1$

## Recipe 4 - Cupcake



Setting catch as a RELATIVE target

## Recipe 5 - Cloutie dumpling



<http://en.wikipedia.org/wiki/Cloutie> ‘

Multiple targets, one with bounds

The order of targets in the control object is important



## Recipe 6 - Panettone



Combining bounds AND relative targets

## A moment of reflection

So far we have looked at projections with:

- absolute target values,
- relative target values,
- bounds on targets, and
- mixed target types.

But all of the projections have been deterministic

No consideration of uncertainty

Prepare yourself!

Because we are about to enter the 6th Dimension. . .

(mangiamo)

## Projecting with uncertainty

`fwd()` is happy to work over iterations

Each iteration is treated separately

There are several main ways of introducing iterations into `fwd()`:

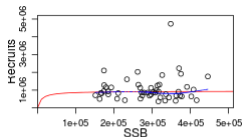
- Residuals to the stock-recruitment function
- Through the control object (set targets with multiple values)
- The stock object you have set up (e.g. stochastic weights-at-age)

You can actually use all of these methods at the same time  
As you can probably imagine, this can quickly become very complicated

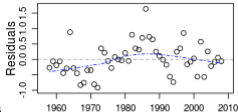
Before cooking, we need to some preparation with the stock object. . .

# Using stock-recruitment residuals

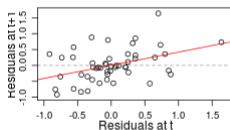
**Functional form**



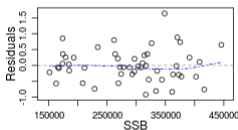
**Residuals by year**



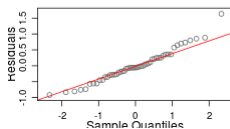
**AR(1) Residuals**



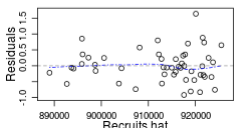
**Residuals by SSB**



**Normal Q-Q Plot**



**Residuals by Estimated Recruits**



## Using stock-recruitment residuals

Two arguments to `fwd()` we have not used yet

- `sr.residuals` - `FLQuant` of residuals
- `sr.residuals.mult` - Are the residuals multiplicative or additive

We need to make an `FLQuant` of residuals. . .

## Recipe 7 - Rum and ginger cake



Introducing stock recruitment residuals

## Recipe 8 - Wedding cake



Stochastic targets

## Recipe 9 - Just a huge cake



Everything all at once. . .