

INTRODUCTION TO FLR

FLR Core Team

November 19, 2010



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Schnute *et al.* (2007 and 1998) compared the number of software tools and languages currently available for stock assessments with the Babel tower myth:

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Schnute *et al.* (2007 and 1998) compared the number of software tools and languages currently available for stock assessments with the Babel tower myth:

"After the people of Babel sought to build a tower to heaven, the Lord God devised a plan (Genesis 11: 4-7). 'Behold the people is one; and they all have one language; and this they began to do; and *now nothing will be restrained from them, which they have imagined to do....* Let us go down, and there confound their language, that they may not understand one another's speech.' Italics highlight the prospects for accomplishment with a common language, if the scientific community could ever agree on one"

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"The cosmic plan for **confounding software languages** seems to be working remarkably well among the community of quantitative fishery scientists!"

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To **promote and generalize** the use of **good quality, open source, flexible software** in all areas of quantitative fisheries research and management advice, with a key focus on Management Strategies Evaluation.

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In detail, FLR aims to facilitate and promote research about:

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- ▶ Stock assessment and provision of management advice

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In detail, FLR aims to facilitate and promote research about:

- ▶ Stock assessment and provision of management advice
- ▶ Data and model validation through simulation

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- ▶ Stock assessment and provision of management advice
- ▶ Data and model validation through simulation
- ▶ Risk analysis

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- ▶ Stock assessment and provision of management advice
- ▶ Data and model validation through simulation
- ▶ Risk analysis
- ▶ Capacity development & education

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- ▶ Stock assessment and provision of management advice
- ▶ Data and model validation through simulation
- ▶ Risk analysis
- ▶ Capacity development & education
- ▶ Promote collaboration and openness in quantitative fisheries science

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- ▶ Stock assessment and provision of management advice
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- ▶ Capacity development & education
- ▶ Promote collaboration and openness in quantitative fisheries science
- ▶ Support the development of new models and methods

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In detail, FLR aims to facilitate and promote research about:

- ▶ Stock assessment and provision of management advice
- ▶ Data and model validation through simulation
- ▶ Risk analysis
- ▶ Capacity development & education
- ▶ Promote collaboration and openness in quantitative fisheries science
- ▶ Support the development of new models and methods
- ▶ Promote the distribution of new models and methods to a wide public.

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- ▶ Started by FEMS EU project

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- ▶ Started by FEMS EU project
- ▶ COMMIT & EFIMAS EU projects provided much of time and sweat

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- ▶ Started by FEMS EU project
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- ▶ Presented to ICES WG Methods 2004

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- ▶ Started by FEMS EU project
- ▶ COMMIT & EFIMAS EU projects provided much of time and sweat
- ▶ Presented to ICES WG Methods 2004
- ▶ FLCore version 1.0 - December 2005
 - ▶ FLQuant with 5 dimensions, no "iter"
 - ▶ Release often, release early. Bugs galore

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- ▶ Started by FEMS EU project
- ▶ COMMIT & EFIMAS EU projects provided much of time and sweat
- ▶ Presented to ICES WG Methods 2004
- ▶ FLCore version 1.0 - December 2005
 - ▶ FLQuant with 5 dimensions, no "iter"
 - ▶ Release often, release early. Bugs galore
- ▶ FLCore version 1.4 - 2007
 - ▶ Stable, full of treats and joy

FLR 1.4 - *The Golden Jackal*

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- ▶ 2007-2009: The Silk Road to version 2
 - ▶ New FLQuant with 6 dimensions: uncertainty in structure
 - ▶ Rewrite of most methods
 - ▶ Extension of methods available
 - ▶ New classes: FLModel
 - ▶ Stronger use of class inheritance
 - ▶ Overhaul of man pages
 - ▶ Simplification of package map

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 - ▶ New classes: FLModel
 - ▶ Stronger use of class inheritance
 - ▶ Overhaul of man pages
 - ▶ Simplification of package map
- ▶ FLCore version 2.0 - January 2009
 - ▶ 2.2: actual stable version
 - ▶ 2.3: under development

FLR 2.2 - *Swordfish Polka*

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The FLR project provides a **platform for quantitative fisheries science** based on the R statistical language. The guiding principles of FLR are:

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The FLR project provides a **platform for quantitative fisheries science** based on the R statistical language. The guiding principles of FLR are:

- ▶ **openness** - through community involvement and the open source ethos

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- ▶ **openness** - through community involvement and the open source ethos
- ▶ **flexibility** - through a design that does not constrain the user to a given paradigm

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- ▶ **openness** - through community involvement and the open source ethos
- ▶ **flexibility** - through a design that does not constrain the user to a given paradigm
- ▶ **extendibility** - through the provision of tools that are ready to be personalized and adapted.

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FLR's framework **facilitates and promotes collaboration** within and across disciplines, e.g. biological, ecological, statistical, mathematical, economic, and social. In particular it ensures that new modelling methods are widely available, so that alternative fisheries management strategies and procedures can be evaluated for their robustness to uncertainty before implementation.

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FLR is distributed with an **open source** license and encourages all packages to be distributed under open source licenses in order **to promote transparency and technology transfer** between disciplines and researchers.

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"Free software is a matter of liberty, not price."

free = free speech

free != free beer

COLLABORATION AND OPEN SOURCE

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"I think the real issue about adoption of open source is that **nobody can really ever 'design' a complex system.** That's simply not how things work: people aren't that smart - nobody is. And what open source allows is to not actually 'design' things, but let them **evolve**, through lots of different pressures in the market, and having the end result just **continually improve**"

Linus Torvalds

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FLR is a **collaborative development project**, where distinct scientists work simultaneously on code, documentation, etc.

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FLR is a **collaborative development project**, where distinct scientists work simultaneously on code, documentation, etc.

- ▶ Development is managed through R-Forge
(<http://r-forge.r-project.org/projects/flr/>)

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(<http://r-forge.r-project.org/projects/flr/>)
- ▶ Packages on repository
(`install.packages(repos="http://flr-project.org/R")`)

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- ▶ Packages on repository (`install.packages(repos="http://flr-project.org/R")`)
- ▶ Documentation on wiki (<http://www.flr-project.org>)

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- ▶ Documentation on wiki (<http://www.flr-project.org>)
- ▶ Funding comes from a number of EU projects (FEMS, COMMIT, EFIMAS, Fisboat, UNCOVER)

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- ▶ Funding comes from a number of EU projects (FEMS, COMMIT, EFIMAS, Fisboat, UNCOVER)
- ▶ FLR Core Team, aka "*Les misérables*", code, maintenance, tests, documentation, etc.

CUT THE CRAP, WHAT IS FLR?

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**A working environment for quantitative fisheries
analysis in R!**

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- ▶ Extendable toolbox for implementing bio-economic simulation models of fishery systems

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- ▶ Extendable toolbox for implementing bio-economic simulation models of fishery systems
- ▶ Tools used by managers (hopefully) as well as scientists

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- ▶ Extendable toolbox for implementing bio-economic simulation models of fishery systems
- ▶ Tools used by managers (hopefully) as well as scientists
- ▶ With many applications including:

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- ▶ Extendable toolbox for implementing bio-economic simulation models of fishery systems
- ▶ Tools used by managers (hopefully) as well as scientists
- ▶ With many applications including:
 - ▶ Fit stock-recruitment relationships,
 - ▶ Model fleet dynamics (including economics),
 - ▶ Simulate and evaluate management procedures and HCRs,
 - ▶ More than just stock assessment (VPA, XSA, ICES uptake)
 - ▶ etc....

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Why do we use R?

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Why do we use R?

- ▶ Existing platform for statistical modelling

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Why do we use R?

- ▶ Existing platform for statistical modelling
- ▶ Good graphics capabilities

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Why do we use R?

- ▶ Existing platform for statistical modelling
- ▶ Good graphics capabilities
- ▶ Multi-platform

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Why do we use R?

- ▶ Existing platform for statistical modelling
- ▶ Good graphics capabilities
- ▶ Multi-platform
- ▶ Open source

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Why do we use R?

- ▶ Existing platform for statistical modelling
- ▶ Good graphics capabilities
- ▶ Multi-platform
- ▶ Open source
- ▶ Links with compiled languages like fortran, C / C++ code for speed

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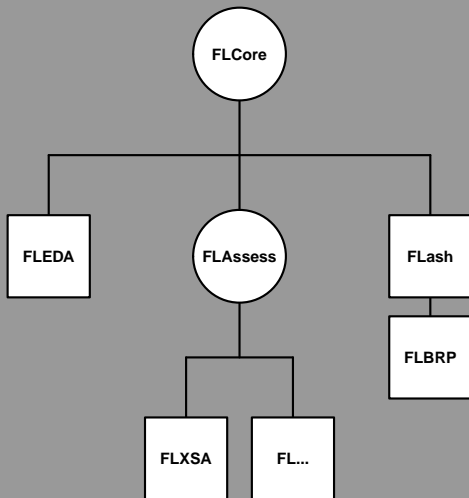
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Why do we use R?

- ▶ Existing platform for statistical modelling
- ▶ Good graphics capabilities
- ▶ Multi-platform
- ▶ Open source
- ▶ Links with compiled languages like fortran, C / C++ code for speed
- ▶ Easily extendable in the form of 'packages'

FLR packages' development model



OBJECT ORIENTED PROGRAMMING WITH S4

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- ▶ A programming language model organized around "objects" rather than "actions"

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- ▶ A programming language model organized around "objects" rather than "actions"
- ▶ Uses R S4 classes

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- ▶ A programming language model organized around "objects" rather than "actions"
- ▶ Uses R S4 classes
- ▶ Everything is an object of a particular class

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- ▶ A programming language model organized around "objects" rather than "actions"
- ▶ Uses R S4 classes
- ▶ Everything is an object of a particular class
- ▶ Objects have:

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- ▶ A programming language model organized around "objects" rather than "actions"
- ▶ Uses R S4 classes
- ▶ Everything is an object of a particular class
- ▶ Objects have:
 - ▶ members (data) and

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- ▶ Uses R S4 classes
- ▶ Everything is an object of a particular class
- ▶ Objects have:
 - ▶ members (data) and
 - ▶ methods (functions associated with it that act on member data)

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- ▶ Objects have:
 - ▶ members (data) and
 - ▶ methods (functions associated with it that act on member data)
- ▶ Inheritance used to extend and create new classes (FLSR inherits from FLModel)

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- ▶ Uses R S4 classes
- ▶ Everything is an object of a particular class
- ▶ Objects have:
 - ▶ members (data) and
 - ▶ methods (functions associated with it that act on member data)
- ▶ Inheritance used to extend and create new classes (FLSR inherits from FLModel)
- ▶ Classes can be members of other classes (most FLR classes include FLQuants as members)

DESIGN PRINCIPLES

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- ▶ Classes to represent different elements of fisheries systems

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- ▶ Classes to represent different elements of fisheries systems
- ▶ 'physical' objects (e.g. FLStock class represents a fish stock)

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- ▶ Classes to represent different elements of fisheries systems
- ▶ 'physical' objects (e.g. FLStock class represents a fish stock)
- ▶ 'methodological' objects (e.g. FLBRP class containing methods to calculate BRP)

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- ▶ Classes to represent different elements of fisheries systems
- ▶ 'physical' objects (e.g. FLStock class represents a fish stock)
- ▶ 'methodological' objects (e.g. FLBRP class containing methods to calculate BRP)
- ▶ Link objects to create simulations - Lego blocks (MSE example)

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- ▶ Classes to represent different elements of fisheries systems
- ▶ 'physical' objects (e.g. FLStock class represents a fish stock)
- ▶ 'methodological' objects (e.g. FLBRP class containing methods to calculate BRP)
- ▶ Link objects to create simulations - Lego blocks (MSE example)
- ▶ Learning curve: trade off between flexibility and simplicity (no black boxes and no handle turning)

FLR & S4

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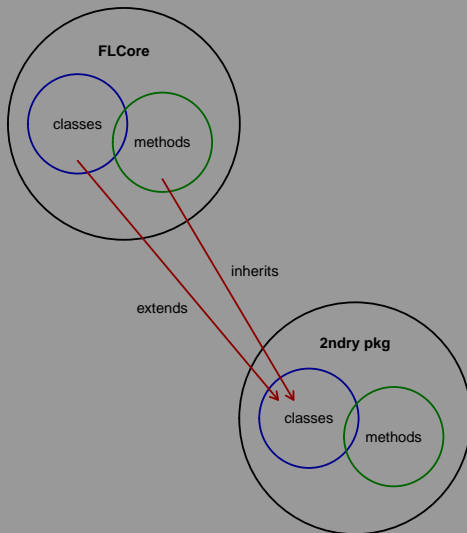
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FLR hierarchical model



MSE - THE LEGO BLOCK APPROACH

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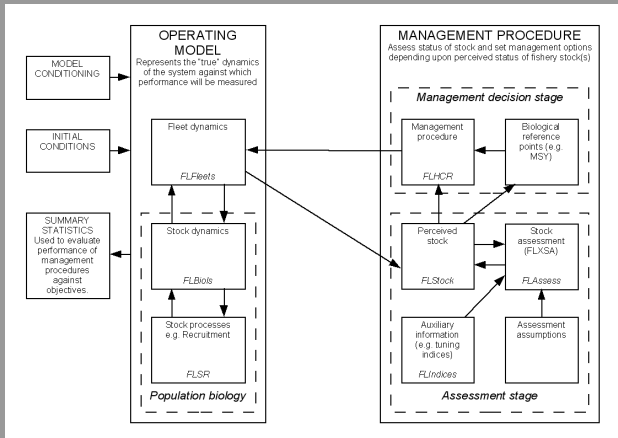
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