**DLMtool training outline (v0.2)**

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**COURSE MODULES**

1. **Introduction**
2. **Running DLMtool**
3. **Customizing DLMtool**
4. **Making recommendations with DLMtool**
5. **Advanced DLMtool**
6. **Robustness testing and ecosystem considerations**

**DEVELOPER NOTES**

**Development dependencies for this version of training materials**

* Renaming internal variables to match slots
* Implementation error class objects (ensures longevity of training materials)
* Performance metrics class functions (ensures longevity of training materials)
* plot(operating model) function; pencil plots; split VOI into VOI and CCU
* Age-dependent M
* StochasticSRA function added (with mean age / mean length flexibility)
* SS2DLM function added

**Documentation dependencies**

* Updated cheat sheets
* The completed case study documents for: the FAO case studies

**Desirable additions**

* More than two area model with user specification of movement
* Surplus production MP added

**Case study dependencies for this version**

* At least two IOTC tuna stocks
* Addition of the ICCAT swordfish case study – (Ask Alex Hanke)

**Module 1: Introduction (~ 2 hours)**

Audience: Non quantitative fisheries audience including: managers, scientists and policy analysts

Purpose: Provide users with a conceptual framework for later modules; brief fishery managers on potential value

Objectives: understand the problem DLMtool solves, its conceptual underpinnings, DLMtool features, its current use in management and see a user friendly demo of DLMtool MSE in action.

Lecture 1a: Foreword (< 10 minutes)

* Objectives
* Intended audience (skill set)
* Course outline
* Online resources

Lecture 1b: Background (~ 30 minutes)

* Problem statement (why we need to ‘crunch the numbers’)
* Terminology
* MSE
* Detailed outcomes (MPs, robustness testing, VOI)

Lecture 1c: What is DLMtool? (~ 30 minutes)

* Overview (free R package, simulation testing, software design considerations)
* Features
* Case studies (SEDAR, California, DFO)
* Correct usage
* Online demo
* Future additions

Lecture 1d: How do management procedures work? (~ 20 minutes)

* Anatomy of an MP
* Schematic examples of MPs

Exercise 1: Online demo (~ 30 minutes)

* Specifying simulations
* Understanding MSE
* Summarizing performance
* Interpreting trade-offs

**Module 2: Running DLMtool (~ 1h 5m)**

Audience: Quantitative fisheries scientists familiar with R

Purpose: Demonstrate how to get DLMtool working and providing familiarity with a DLMtool MSE process

Objectives: Get all users to the same stage WRT software installation before continuing with later modules; Understand the basic structure of a DLMtool MSE run; reinforce an understanding of what performance metrics are telling us (e.g. what is a simulation, really what is POF?)

Lecture 2a: Getting started (~ 10 minutes)

* Installation (Rstudio, R, installing package from CRAN)
* Loading the package
* Setting up parallel processing and loading objects
* Check installation and test run
* Getting help

Lecture 2b: A simple ‘no frills’ run of DLMtool (~ 30 minutes)

* SOO design: Stock, Fleet, Observation and Implementation objects
* Constructing operating models
* Visualizing operating models
* Running an MSE
* Visualizing MSE runs
* Evaluating performance
* Trade-off plots

Exercise 2a: An R script for installation and validating installation (~ 10 minutes)

Exercise 2b: A basic DLMtool run (~ 15 minutes)

* Finding alternative pre-specified stock fleet and observation objects
* Evaluating MSE outcomes for varying operating models
* Understanding the various pre-specified performance metrics

**Module 3: Customizing DLMtool (~ 4 hours)**

Audience: Quantitative fisheries scientists familiar with R

Purpose: Educate and inform users on some of the basic functionality / flexibility of the toolkit

Objectives: Understand OO design of DLMtool, be able to customize operating models, MSE running options and produce custom performance metrics

Lecture 3a: Modifying operating models (~ 1 hour)

* .csv input file conventions
* Stock objects
* Fleet objects
* Observation objects
* Implementation error objects

Lecture 3b: Plotting MSE outputs (~ 30 minutes)

* Convergence diagnostics
* Pplot, Kplot, Tplot, pencil plot
* Value of information (VOI)
* Cost of current uncertainties (CCU)

Lecture 3c: Custom performance analysis (~ 30 minutes)

* Interpreting the data stored in the MSE object (MSE object structure)
* Designing performance metrics
* User plots
* User value of information
* Value of new data

Exercise 3a: Modifying operating models (~ 1 hour)

Exercise 3b: Plotting outputs (~ 30 minutes)

Exercise 3c: Custom performance metrics (~ 30 minutes)

**Module 4: Making recommendations with DLMtool (~ 2h 20m)**

Audience: PhD level quantitative fisheries scientists familiar with R (who have completed Module 3)

Purpose: Make management recommendations using DLMtool

Objectives: Learn how to process data to provide management advice using the MPs of DLMtool

Lecture 4a: The format of fishery data for DLMtool (~ 30 minutes)

* Time series data
* Parameters
* Uncertainty

Lecture 4b: Running MPs (~ 40 minutes)

* Can / Can’t / Needed functions
* Calculating TAC or effort recommendations
* Sensitivity analysis

Exercise 4a: Processing data (~ 30 minutes)

* .csv files
* Read/write functions

Exercise 4b: Calculating management advice (~ 40 minutes)

* Plotting outputs
* Conducting sensitivity analysis

**Module 5: Advanced DLMtool (~ 4h 10m)**

Audience: PhD level quantitative fisheries scientists familiar with R (who have completed Module 3)

Purpose: Build on previous models to provide a complete account of DLMtool functionality

Objectives: Learn advanced features of DLMtool – currently big issues are OM specification and custom MPs

Lecture 5a: Advanced operating model specification (~ 30 minutes)

* Time varying selectivity
* Age dependent natural mortality rate
* Parameter cross correlation
* Conditioning operating models by SRA
* Conditioning operating models by SS

Lecture 5b: Custom Management Procedures 1: output controls (~ 40 minutes)

* The format of DLMtool simulated data (DLMdata)
* A constant catch MP
* A simple mean catch depletion MP
* A catch curve analysis
* A stock assessment model

Lecture 5c: Custom MPs 2: input controls (~ 30 minutes)

* Size limits (relative to maturity and in absolute terms)
* Spatial controls
* Effort controls
* Combinations

Exercise 5a: Advanced operating model specification (~ 30 minutes)

* Time varying selectivity / age dependent M
* Preserving correlation among estimated growth parameters (what difference?)
* CatchCompSRA() function and interpreting outputs

Exercise 5b: Custom output control MPs (~ 40 minutes)

Exercise 5c: Custom input control MPs (~ 30 minutes)

Exercise 5d: (Optional) Conditioning MPs (~ 30 minutes)

**Module 6: Robustness Testing and Ecosystem Considerations (~ 2h 40m)**

Audience: Quantitative fishery scientists familiar with R (who have completed Module 3)

Purpose: Demonstrate the role of robustness testing and provide examples of how wider ecosystem impacts may be addressed by simulating time-varying operating model parameters

Objectives: Users should understand the difference between sensitivity in management recommendations versus sensitivity in selection of management procedures. Users should consider what ecosystem changes may be occurring in their system and construct operating models to address these.

Lecture 6a: Robustness testing and MP selection (~ 40 minutes)

* Quality of data
* Fishing efficiency (output versus input controls)
* Asymmetry in risk of model assumptions (steepness, M etc)
* Gaining confidence in a management system

Lecture 6b: Time varying parameters and ecosystem considerations (~ 40 minutes)

* Growth
* M
* Recruitment
* MP selection

Exercise 6a: Robustness testing (~40 minutes)

Exercise 6b: Time varying parameters and ecosystem considerations (~40 minutes)

**Case Study 1: IOTC case study, longtail tuna (~3 hours)**

Audience: Quantitative fishery scientists familiar with R (who have completed Module 3)

Purpose: Describe how operating models were developed for a data-limited ABNJ tuna stock

Objectives: Users should understand the various data-limited methods for specifying operating models that make use of life-history theory, imputation and historical stock reconstruction

Lecture CS1: longtail tuna operating model specification (~1 hour)

Exercise CS1: longtail tuna analyses and interpretation (~2 hours)

**Case Study 2: IOTC case study, yellowfin tuna (~3 hours)**

Audience: Quantitative fishery scientists familiar with R (who have completed Module 3)

Purpose: Describe how operating models were developed for a relatively data rich ABNJ tuna stock

Objectives: Users should understand how to convert stock assessment outputs to DLMtool operating model specification using the various tools available in the package.

Lecture CS1: yellowfin tuna operating model specification (~1 hour)

Exercise CS1: yellowfin tuna analyses and interpretation (~2 hours)

**Case Study 3: ICCAT case study 1**

**Case Study 4: ICCAT case study 2**

**Case Study 5: IATTC case study 1**

**Case Study 6: IATTC case study 2**

**Case Study 7: IATTC case study 3**

**Case Study 8: IATTC case study 4**