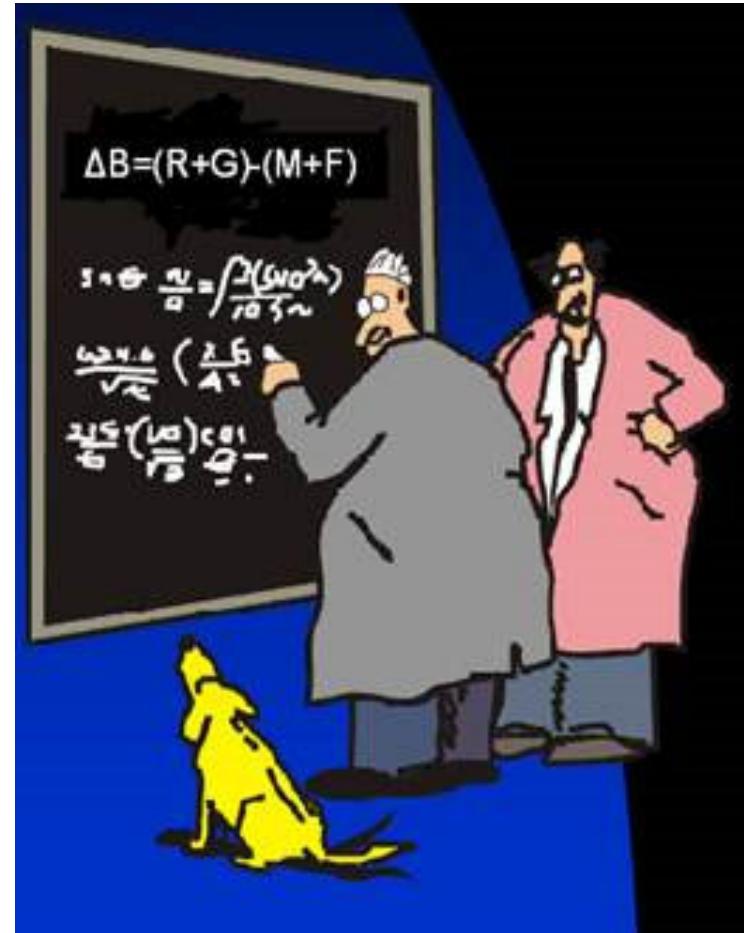


Training the next generation of stock assessment scientists

Noel Cadigan, CFER

TESA workshop “Small Pelagic Fishes”
November 21-23, 2023
Gulf Fisheries Centre, Moncton



My Training Experience at MI

MASTER'S DEGREE

FISHERIES SCIENCE

STOCK ASSESSMENT

ON CAMPUS

PROGRAM DESCRIPTION

The degree of Master of Science in Fisheries Science (Stock Assessment) is a full-time, research-focused Master's degree offered by the Marine Institute's School of Fisheries. This program is for students who aim to pursue a career in stock assessment, a discipline within fisheries science.

Stock assessment professionals use data derived from many sources to construct statistical models that inform us about biomass of organisms in the ocean and how many can be caught sustainably. While stock assessment professionals must have many of the same proficiencies as other fisheries scientists, they have an additional requirement of being experts on the mathematics and statistics that underpin this heavily quantitative field.

ADMISSION REQUIREMENTS

To be considered for admission to the program, an applicant will normally possess a high second class Honours degree or an M.D. degree, or the equivalent of either, both in achievement and depth of study from an institution of recognized standing. Applicants must be able to demonstrate a satisfactory knowledge of mathematics, statistics and scientific computing.

Any other applicant may be considered for admission provided that:

- The applicant's undergraduate record after the first year shows an average of at least Grade B in courses in the proposed field of specialization;
- The applicant's overall undergraduate record after the first year shows an average of at least Grade B in all courses taken; and
- The applicant demonstrates a commitment and passion for mathematics or statistics, through employment or experience in field schools, research programs, regulatory agencies or government departments, non-governmental organizations, consulting activities, or other relevant activities.





MSc: Fisheries Science (Stock Assessment - SA)

- 12 credit hours including:
 - FISH 6000 Science Communication for Fisheries
 - FISH 6001 Ecology, Management, and Practice of North Atlantic Fisheries
 - FISH 6004 Overview of Statistical Stock Assessment
 - FISH 6005 Advanced Statistical Stock Assessment
- A thesis composed of at least one chapter of original research.
- A student may be required by the Supervisory Committee to take additional courses.

FISH 6004 Overview of Statistical Stock Assessment

Overview of fish stock assessment (3-hour blocks)

Fisheries Dependent and Independent (Surveys) Indices of Stock Size

Population Models and Management Reference Points

Models, Data, and Statistical Inference using R (6 hours)

Growth of Individual Fish

Population Model Estimation and Inference

Stock Recruitment models

Age Structured Population Models

Virtual and Sequential Population Analysis

Modern Stock Assessment

FISH 6005 Advanced Statistical Stock Assessment

- Random effect models and TMB
- Time-series growth models for fish populations
- Time-varying stock-recruit models
- State-space production model
- State-space SURBA
- State-space Age-structured Stock Assessment Model
- Multispecies modelling in fisheries / Ecosystem-based Fisheries Management and Ecosystem Models
- Introduction to Management Strategy Evaluation (MSE)
- Two major projects. E.g.
 - State-Space Age-Structured Catch-at-Length Stock Assessment Model for Thorny Skate in NAFO Divisions 3LNOPs
 - Estimating reference points for 3LNOPs thorny skate

Current Status of SA MSc Program

- Dormant
- No faculty are recruiting students into the SA MSc so there is no requirement to teach SA courses
- It is an on-campus research-based MSc, with funding provided to students from supervisors
- Very small pool of potential students, mostly internationals with no fisheries background, or an aquaculture background.
- Only 1 faculty member with SA as a main focus, which is not enough to support an MSc program.
- New MI grad students all do the other MSc program: Fisheries Science (Fisheries Science and Technology)

SA MSc Program

- Thesis requirement was a conflict with how many courses students could take
- Students with quantitative background usually had scant biology background
- And vice-versa
- It may be unreasonable to expect publishable SA methods thesis research to be led by an MSc student
- Can't primary publish SA applications
- But we get funding for projects, not teaching
- Teaching/supervision of MSc students can substantially reduce SA faculty research productivity

Maunder and Piner, 2014. Contemporary fisheries stock assessment: many issues still remain. – ICES Journal of Marine Science

As large as the data gap is, the lack of highly trained stock assessment scientists and the finite time available for the limited number of qualified scientists that exist currently (Berkson *et al.*, 2009a, b) may turn out to be an even larger obstacle to improving fisheries management. To be useful for fisheries management, the multiple

to retirement. Part of the problem is a lack of critical mass in academic institutions due to the specialized nature of stock assessment, and improvements in this situation may require collaboration among academic institutions. Too much time is spent on attempt-

among academic institutions. Too much time is spent on attempting to train life science graduates using short courses in the fundamentals of stock assessment. Short courses are insufficient to train qualified scientists and keep their interest. These courses usually lack the basic mathematical content to underpin participants understanding of stock assessment concepts. Applied mathematics

graduate students trained overseas often stay overseas. A 1-year post-PhD diploma programme to retrain quantitative ecologists, statisticians, and other quantitatively trained scientists may be the quickest way to train the stock assessment scientists needed. The programme may require collaboration between multiple universities and management agencies to contain the courses needed and provide mentoring and practical experience. However, such a

New SA Masters Concept

1. The head of the School of Fisheries at MI is leading/exploring the idea of creating an online and course-based master's program.
2. I suspect this will normally be completed part-time, over at least 9 semesters, similar to other online master's programs at MI and MUN.
3. E.g., Master of Marine Studies (Fisheries Resource Management)
 - Option 1 requires five core courses (15 credit hours), three elective courses (9 credit hours), and a major report.
 - Option 2 requires five core courses (15 credit hours) and five elective courses (15 credit hours)

My 10 Course Ideas for Online Program

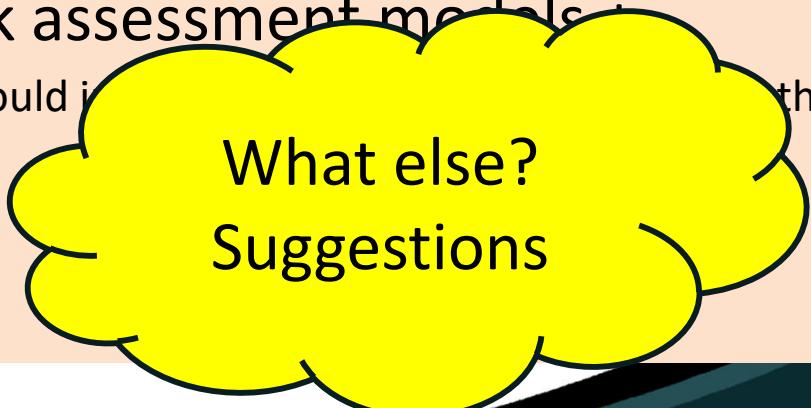
1. Marine fisheries ecology (*in the North Atlantic vs online?*)
2. Introduction to Stock Assessment (surplus production models, age based (VPA, and SCA), age-based productivity (Len@Age, W@Age, Mat@Age, stage-based))
3. Fisheries management strategies (include YPR, SPR, reference points, stock-recruit models, projections, MSY, and MSE)
4. Statistical concepts for stock assessment (the basics: probability and distribution theory, sufficiency, completeness, ancillarity, conditioning, point estimation, Interval estimation, Hypothesis testing, Likelihood ratio test, Wald and score tests)
5. Fitting custom models with TMB (lots of practice, coding ideas, using functions, maybe include RTMB, simple models useful for stock assessment)

My 10 Course Ideas for Online Program

6. Stat 6545 Computational statistics (e.g., basic optimization techniques, permutation tests, bootstrapping, cross-validation, the Expectation-Maximization (EM) algorithm, and Monte Carlo algorithms, including importance sampling, Markov Chain Monte Carlo (MCMC) and Sequential Monte Carlo (SMC))
7. Mixed effects and state-space models (focus on marginal maximum likelihood estimation; incl year-class strength, binomial logistic regression with random effects, SPM with process errors)
8. Analysis of fisheries surveys (incl. design-based inference, length-stratified age samples, spatiotemporal correlation and model-based estimation: e.g., weight-at-length; maturity-at-length; size composition, mean number per tow, etc.)
9. State-space integrated stock assessment models + practicum (mostly age-based, but could introduce length-based and age-length-based)
10. Science Communications

My 10 Course Ideas for Online Program

6. Stat 6545 Computational statistics (e.g., basic optimization techniques, permutation tests, bootstrapping, cross-validation, the Expectation-Maximization (EM) algorithm, and Monte Carlo algorithms, including importance sampling, Markov Chain Monte Carlo (MCMC) and Sequential Monte Carlo (SMC))
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What else?
Suggestions

New Masters Concept

- Will the demand for this program be high enough?
- MI does not currently have the capacity to deliver these 10 courses
- I don't think other MUN departments can help either
- JUST IN: "*There is a collective interest with the faculty of science*" about stock assessment masters??
- However, it is useful to first create the wish-list of courses
- And then prioritize
- What do potential students want?
- Do DFO staff want to take courses that you can pass/fail, and not just get a certificate of attendance?
- Is masters the right level?

New Masters Concept

- Stock assessment training needs to involve much practice, and real-life experience
- Sort of like teaching swimming – you can only do so much in a classroom.
- Eventually students needs to get in the pool



“I think it would be a good idea”

FISH 576: Applied Stock Assessment I (2-5 credits); Winter Quarter

Drs. Melissa A. Haltuch and Owen S. Hamel
melissa.haltuch@noaa.gov, owen.hamel@noaa.gov
206-920-1193, 206-697-3102

Recommended Skills and Knowledge:
R or similar (C++) programming experience.
Basic knowledge of population dynamics.

User training

Overview

Applied Stock Assessment I is the first part of a two-quarter applied stock assessment series offered in collaboration with stock assessment scientists in the Fishery Resource Analysis and Monitoring Division at the Northwest Fisheries Science Center. This course provides a review of population dynamic modeling basics and stock assessment data types, and then focuses on the details of processing fishery and survey data for use in stock assessment and running Stock Synthesis stock assessment models. The work products from this course will be submitted to the Pacific Fishery Management Council (PFMC) for use in management, thus PFMC's documentation requirements are reviewed early in the term. During this first term, students will work as a team to:

- 1) Review assessment documents, STAR reports, and identify new literature
- 2) Work up data for the update assessments
- 3) Update data as each data source is finalized
- 4) Begin work on producing an update stock assessment that involves updating and adding recent data from all data sources used in the previously reviewed stock assessment adopted for management.
- 5) Begin work on catch-only stock assessment projections.

Format

One 1.5-hour lecture and one 1.5 hour laboratory each week in which the instructors first introduce the theory behind the topic being discussed and the practical approach including decision points and code. Depending on the topic, students start the process of applying the methods to the stock assessment update and/or catch only projections and possibly additional examples during the laboratory session.

Learning Goals

Upon successful completion of the course, students will be able to:

1. Evaluate and process length and age composition data and fishery-independent indices.
2. Evaluate and process survey index data.
3. Run existing Stock Synthesis models and replace or extend data in input files for catch, indices, composition, discard, and environmental data.
4. Understand basic modeling assumptions and when they might be violated.

Another Idea: National Centre for Stock Assessment Training and Research (NCSATR)

1. Clients: graduate students and DFO staff
2. Organize and deliver annual training workshops (3?, 1 week per) on methods for SA.
3. Organize and deliver online training modules/courses on marine population dynamics, statistics for SA, and SA. May be evaluated.
4. Organize research working groups (aka CRTs, e.g., redfish etc).
5. Fund and supervise *graduate students?* and pdfs to advance methods in CRTs. This is an important part of training.
6. Organize symposia (e.g., ~ 5 years) on SA methods for the Canadian context.
7. 2 -> 6 should develop gradually and progressively.
8. 4&5 are highly aspirational and but maybe unrealistic

Why NCSATR?

1. Draw on more experts to deliver content, and supervise
2. Participate *a la carte*
3. More program flexibility
4. More flexibility for evaluations
5. Training future SA researchers should involve practice.
 - including students and PDFs (HQP) in CRTs is a good way to train HQP, and also get some useful results
 - i.e., more pool time!
 - Team supervision of HQP

Why NCSATR?

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 - i.e., more pool time!
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NCSATR

1. Include a) Scientific Advisory board with international experts, and b) Domestic industry advisory board
2. Why? Help ensure latest content is delivered; give industry another opportunity to advance their sustainability objectives
3. Budget???? options
 - a. Seek funds (START-UP) to deliver workshops, including travel costs for participants, or for students only? Travel and hosting costs for working groups? Symposium costs? Graduate student or PDF funding?
 - b. CFI, NSERC CREATE, DFO, ...
 - c. Maybe industry can contribute wrt \$\$\$, esp. for CRTs
 - d. Or self-fund via cost recovery.
 - e. Some combination of the above
4. Host Institutions: MUN, DAL, U Vic, Simon Fraser, UBC, Laval, ...
5. Governance. Need a director, admin support, ...



Examples of National Centers in Canada

/the-nccph-program/

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National Collaborating Centre
for Determinants of Health
Centre de collaboration nationale
des déterminants de la santé

OUR CENTRE

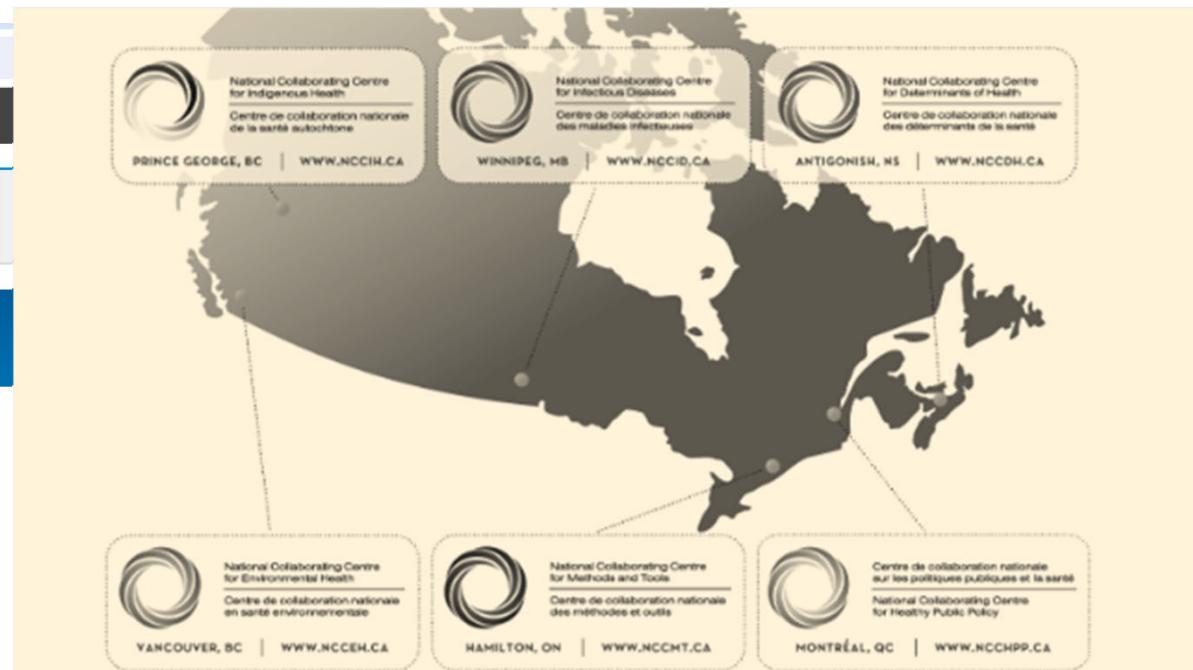
OUR WORK

The NCCPH program



National Collaborating Centres
for Public Health
Centres de collaboration nationale
en santé publique

Established in 2005 and funded through the Public Health Agency of Canada, the National Collaborating Centres (NCCs) for Public Health produce information to help public health professionals improve their response to public health threats, chronic disease and injury, infectious diseases and health inequities. The NCCs are located across Canada, and each focuses on a different public health priority.



The six centres are:

- National Collaborating Centre for Indigenous Health (NCCIH)
- National Collaborating Centre for Environmental Health (NCCEH)
- National Collaborating Centre for Infectious Disease (NCCID)
- National Collaborating Centre for Methods and Tools (NCCMT)
- National Collaborating Centre for Healthy Public Policy (NCCHPP)
- National Collaborating Centre for Determinants of Health (NCCDH)

The National Collaborating Centre for Determinants of Health is proud to work closely with the other National Collaborating Centres for Public Health on several joint projects and initiatives.

With other NCCs, we have:

- developed resources to support health equity across Canada;
- partnered at user forums, conference presentations and workshops;
- coordinated joint webinars.

Examples of National Centers in Canada



Canada's National Design Network (CNDN)

Queen's University

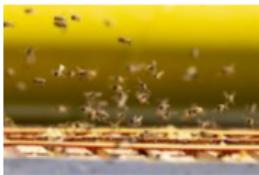
National facility for undertaking leading-edge R&D in micro-nanotechnologies, foundational to all industrial sectors and essential to Canada's competitiveness.



National Experimental Biology Centre

Université du Québec - Institut national de la recherche scientifique (INRS)

Animal experiments: toxicity, pharmacokinetics, drug efficiency (from rodents to primates). Animal housing and full vivarium service for your own experiments.



National Bee Diagnostic Centre (NBDC)

Northwestern Polytechnic (Grande Prairie Regional College)

The only dedicated laboratory in Canada providing comprehensive diagnostic services to the beekeeping industry for a healthy, sustainable and profitable apiculture.



National Centre for Livestock and the Environment (NCLE)

University of Manitoba

Research on long term sustainability of integrated livestock and crop production systems



National Center for Electrochemistry and

- These centers seem to involve just one university
- They don't seem national?
- Universities tend to not play well together
- Why get involved?

Ocean Graduate Excellence Network (OGEN)

Shape the future of the ocean

Ocean Graduate Excellence Network

Ocean School

International Postdoctoral Fellowship

Industrial Postdoctoral Fellowship

Visiting Fellowship

Ambassador

About Get Involved Resources Contact

About the Ocean Graduate Excellence Network

The Ocean Graduate Excellence Network (OGEN) unites graduate training with industry and government partners to provide a full-spectrum experience and shape the future of ocean research and the ocean workforce.

Students pursue a graduate degree at their home institution, while also participating in additional skill-developing activities. In addition to a generous stipend, students receive a dedicated budget for co-curricular activities that support professional development beyond academia.

Academic supervisors and government and industry partners have the opportunity to leverage funds and attract the brightest minds to join the Canadian ocean research ecosystem.

Academic partners



Maybe this is something OFI could help with, but it may have to be DAL led?

What's Happening in the US

The screenshot shows a browser window with the title "Stock Assessment Training Prog" and a URL bar containing "v/national/population-assessments/stock-assessment-training-program#~:text=NOAA%20Fisheries'%20stock%20assessment%20professional,stock%20assessments%20in%20all%20regions." A Google search icon is visible in the top right corner.

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NOAA Fisheries' stock assessment professional development program provides stock assessment scientists with ongoing, consistent opportunities for continued education and training in the evolving skills necessary for next generation stock assessments in all regions. Through in-person and online training workshops, fisheries scientists can obtain educational opportunities to advance their knowledge and skills at the forefront of fisheries population dynamics. This training webpage provides an information portal for training resources for fisheries population dynamics scientists.

2020

Stock Synthesis: Intro to the Stock Synthesis Interface

Instructor: Richard Methot

Date: March 19, 2020

Location: Online Webinar

Contact: abigail.furnish@noaa.gov

Species Distribution Modeling

Instructors: James Thorson and Elliott Hazen

Intro to Github

Instructors: Corinne Bassin and Christine Stawitz

Date: April 20, 2020 (both workshops held in conjunction with National Stock Assessment Workshop)

Location: Providence, RI

2019

Stock Synthesis: Selectivity and Catchability

Instructor: Richard Methot

Date: March 7, 2019

Location: Online Webinar

Contact: abigail.furnish@noaa.gov

VAST: Spatio-Temporal Analysis

What's Happening in the US

 fisheries.noaa.gov/resource/student-opportunity/quantitative-ecology-and-socioeconomics-training

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION | U.S. DEPARTMENT OF COMMERCE

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RESOURCES

Quantitative Ecology and Socioeconomics Training

October 15, 2018

QUEST educates and trains the next generation of ecosystem scientists, stock assessment scientists, and economists. It also provides learning and training opportunities on the science behind fisheries management to the general public.

Quantitative Ecology and Socioeconomics Training

[Student Opportunity](#) | National

QUEST functions as a "**virtual institute**" to help connect faculty, graduate students, and undergraduates with NOAA Fisheries scientists in the fields of quantitative ecology and socioeconomics and to promote information exchange. It also helps provide education and training opportunities for scientists, faculty, and graduate and undergraduate students.

Last updated on 02/27/2019

What's Happening in the US

The screenshot shows a web browser displaying the NMFS-Sea Grant Fellowship Program website. The URL in the address bar is seagrant.noaa.gov/NMFS-SG-Fellowship/. The page features a dark header with the Sea Grant logo and a search bar. Below the header is a large banner image of an underwater scene with fish and coral. Overlaid on the banner is the text "JOINT FELLOWSHIP PROGRAM" in large white letters, followed by "NOAA Fisheries & Sea Grant" in smaller white letters. A descriptive paragraph explains the program's purpose: "The NMFS-Sea Grant Joint Fellowship Program in Population and Ecosystem Dynamics and Marine Resource Economics is designed to help Sea Grant fulfill its broad educational responsibilities and to strengthen the collaboration between Sea Grant and the National Marine Fisheries Service (NMFS)." At the bottom of the page, there are sections for "Important Dates" and "POPULATION & ECOSYSTEM DYNAMICS". The status bar at the bottom of the browser shows the date as January 25, 2024, and the weather as 2°C Mostly cloudy.

seagrant.noaa.gov/NMFS-SG-Fellowship/

An official website of the United States government Here's how you know

Sea Grant

Home » NMFS-Sea Grant Fellowship

JOINT FELLOWSHIP PROGRAM

NOAA Fisheries & Sea Grant

The NMFS-Sea Grant Joint Fellowship Program in Population and Ecosystem Dynamics and Marine Resource Economics is designed to help Sea Grant fulfill its broad educational responsibilities and to strengthen the collaboration between Sea Grant and the National Marine Fisheries Service (NMFS).

Important Dates

Applications due to your state's Sea Grant program on January 25, 2024, for the 2024 Fellowship

Selected applicants will be notified in summer 2024

POPULATION & ECOSYSTEM DYNAMICS

Type here to search

2°C Mostly cloudy

CAPAM

- “Technical training on fisheries stock assessment” on June 12, 2019 in Manta, Ecuador.
- "Stock Synthesis" during January 22 to 26, 2018 in Concepcion, Chile.
- "Stock Synthesis" during October 2-6, 2017 in Rome, Italy.
- Harvest Strategy Evaluation in fishery resources during December 12-16, 2016 at INIDEP, Mar del Plata, Argentina.
- "Stock Synthesis" during November 14-18, 2016 at the IMARPE, Callao, Peru.
- “Stock Synthesis” during March 7-11, 2016 at INIDEP, Mar del Plata, Argentina.
- "Stock Synthesis" during September 8-15, 2014 at the CICIMAR, La Paz, Mexico.

Are Accreditation Ideas Helpful?



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ACCREDITATION

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ACCREDITATION

Please click an option to navigate to that page.

Information about Accreditation

Learn about the requirements and application procedures for SSC Accreditation.

Application for Accreditation

Get to know the accreditation documents.

Applying for Accredited Status for an Educational Program

Accreditation of undergraduate programs in statistics.

Accreditation of Statisticians by the Statistical Society of Canada

Regulations for the SSC accreditation programs.

Should there be minimum standards for stock assessors or graduates?

Benefits of Accreditation

Become a recognized statistics professional and enhance your statistical practice.

Mentorship Program

Learn about the SSC Mentorship Program for Accredited Statisticians.

Accredited Courses

A list of Accredited Courses that may be used towards the A.Stat. designation.

Directory of Accredited Statisticians

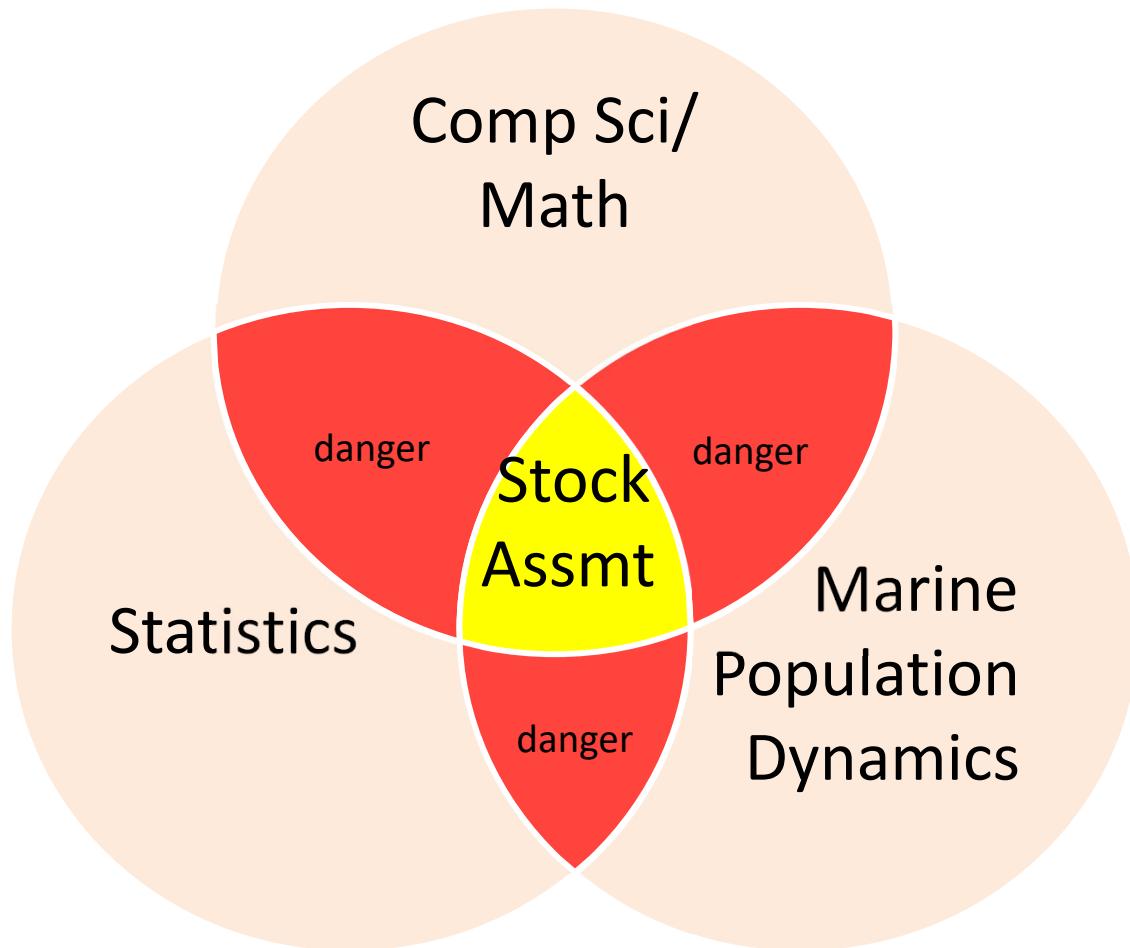
Search for accredited members in the Directory of Accredited Statisticians.

Discussion Points

1. What is stock assessment (SA)?
2. What are the key skills required to do this well?
3. What is the demand for SA training?
4. Big decision point: Train users or developers?
5. Accredited training (with evaluations) or not?
6. Does any university in Canada have enough faculty to provide a comprehensive SA training graduate program? I think no...
7. A collaborative approach seems necessary
8. Masters-level SA skills will be limited; there is a lot to teach.
Graduates should be able to extend existing models.
9. A post-PhD or post-MSc program? Diplomas or certificates?

Summary of TESA Workshop Discussion

1. For the online master's program, in addition to the courses I outlined, there is a need for advanced R/programming training.
2. The stock assessment skills Venn diagram, adapted from Maunder:



Summary of TESA Workshop Discussion

1. The sequence of online courses will need to be considered. Some of these courses will be prerequisites for others?
2. Undergrad and grad students may not find the online master's program I described interesting.
3. Students want field experience too!
 - *But field work not part of stock assessment training?*
 - *Is attending assessment meetings considered stock assessment field work?*
4. The online Masters program and courses as described will be more interesting to early career stage DFO staff.
5. More useful if a graduate program has national scope, which should impact the content of some courses.
6. Should try to make the training more generic, to have broader appeal to students.

Summary of TESA Workshop Discussion

1. Student recruitment will be an issue.
2. Need to consider cost-benefits?
3. How many stock-assessment jobs are there in Canada?
4. A graduate program will also need to target international students too, and this will impact course contents.
5. US universities can get funding from NOAA to do stock assessment research. This involves training.
6. The advantage of training before hiring is that you know what you are hiring.
7. DFO often hires then trains, which is risky because you have less knowledge of the skills of the person being hired.

Summary of TESA Workshop Discussion

1. A national center with workshop-style courses may be more interesting to graduate students, because of social interactions with other participants, etc. – the flavor of field-work.
2. Such an institute may be more useful for DFO training needs
3. Target post-MSc researchers
4. A national center needs champions within and outside DFO
5. Check the *Canadian Rivers Institute* for their thoughts on a national institute
6. Contact Rob Stevenson (DFO Maritimes) for his experience leading CCFRN

My Additional Ideas

1. The TESA meeting participants did not indicate that getting another masters degree was important to them; they already have MSc's/PhD's.
2. Conceptually, a national center could provide “stock assessment community” based training
3. Workshops/short courses/training modules/etc that provide training “credits”
4. Participants get an advanced diploma/certificate if enough credits are achieved.
5. Develop a national focus, which will take time
6. Training needs to be flexible/nimble to respond to demands and adapt to changing circumstances
7. Traditional graduate programs have low flexibility.
8. “outside the box” training is innovative and maybe easier to attract funding for