Competitive Science Research Fund (CSRF) **Full Proposal Application 2022-23**

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| **Project code**  (reserved to SFS) |
| Enter code |

This form is to be used to submit an application to the CSRF for fiscal year 2022-23.

ALL sections must be completed, except where noted “if applicable”. Note that some of these fields can be copy & pasted from your Letter of Intent (LOI).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1. Research Area:** | | Stock assessment science | | | | | | | | | | **4. Priority identification number (PIN):** | |
| **2. Research Focus:** | | Ecosystem Approach to Fisheries Management | | | | | | | | | | FS-22-01 | |
| **3. Research Priority:** | | Incorporation of Environmental Variables into Stock Assessment and Science Advice: Developing and testing analytical approaches to facilitate the incorporation of environmental variables, i.e., climate, oceanographic and ecosystem factors, into stock assessment and science advice, including impacts on subsequent decision making. | | | | | | | | | |
| **5. Project Identification** | | | | | | | | | | | | | |
| **5.1 Project Title:** | | EcoTest: Robust Fishery Management Advice for Changing Ecosystems | | | | | | | | | | | |
| **5.2 Keywords** – list 3-5 keywords that describe your project | | | | | | Groundfish, Stock assessment, Ecosystem Approach/Based Fishery Management, Management Strategy Evaluation | | | | | | | |
| **5.3 Amount of requested funding** - Enter total cost of project (in O&M) [last cell of table in section 10.2] | | | | | | | | | | | | $276,000 | |
| **5.4 Duration of requested funding** - Enter 1, 2, or 3 years | | | | | | | | | | | | 3 years | |
| **5.5** If the project will take longer than 3 years, specify the expected total duration (if applicable) | | | | | | | | | | | | Select an item | |
| **5.6 Principal Investigator (PI):** | | Name: Yanjun Wang  Email: Yanjun.Wang@dfo-mpo.gc.ca | | | | | **Lead Region:** | | Maritimes | | | | |
| **5.7 Co-PI**  (if applicable): | | Enter name  Enter email (\_\_@dfo-mpo.gc.ca) | | | | | **Co-PI Region**  (if applicable): | | Select region | | | | |
| **6. Research team** (list all key collaborators/partners and provide the % of FTE time going towards the project)**:** | | | | | | | | | | | | | |
| **Name** | | **Role in the project**  (estimated % FTE time, and key expertise) | | | | | **Affiliation** | | | | | | |
| Yanjun Wang | | Project co-lead, research scientist,  Member of Maritimes region EBFM working group and Can./U.S. EBFM working group  Key expertise: stock assessment modelling  25%FTE | | | | | DFO-MAR | | If external, enter the institution | | | | |
| Dr. Thomas Carruthers | | Project co-lead / supervisor  Key expertise: stock assessment and ecosystem modelling, MSE; developer of openMSE R package  25% FTE | | | | | External | | Blue Matter Science Ltd. | | | | |
| A post-doctoral researcher | | Lead analyst  50% FTE | | | | | External | | Blue Matter Science Ltd. | | | | |
| Monica Finely | | Stock assessment lead of haddock stocks  Role: Provide data and feedback  Expertise: haddock fishery  5%FTE | | | | | DFO-MAR | | If external, enter the institution | | | | |
| Caira Clark | | Stock assessment lead of 4X5Y cod  Role: Provide data and feedback  Expertise: cod fishery  5%FTE | | | | | DFO-MAR | | If external, enter the institution | | | | |
| Enter name | | Click to enter text | | | | | Select an item | | If external, enter the institution | | | | |
| Enter any additional information about the partnerships and collaborations relevant to the project (Ex./ if an MOU is required, etc.) (150 words max). | | | | | | | | | | | | | |
| Collaborators are providing data and expertise through in-kind contributions. | | | | | | | | | | | | | |
| **7. Client Engagement** – Identify the client colleague with whom you are discussing this proposal (Name and client sector, region) and briefly explain discussions had to date (number of conversations, nature of discussion [ex/ agreement on deliverables, clarification of research question, etc.]) (100 words max). | | | | | | | | | | | | | |
| **7.1 Client Name(s) and client sector** | | Kathy Cooper-McDonald & Penny Doherty  Resource Management | | | | | **Region** | | Maritimes | | | | |
| The impact of Ecosystem changes on fish stock dynamics and subsequent management decisions will be incorporated and tested on three case study stocks (5Zjm haddock, 4X5Y Cod, and 4X5Y haddock). Resource managers, Penny Doherty (4X5Y groundfish resource manager) and Kathy Cooper-MacDonald (Georges Bank resource manager and TMGC member), have indicated this research would have impacts to stock decision making and would meet new requirements under changes to the Fisheries Act (C-68). The resource managers would be happy to provide their perspectives on management strategies to be tested and to ensure their requirements are met. | | | | | | | | | | | | | |
| **8. Project Description** | | | | | | | | | | | | | |
| **8.1 Overview** – Provide a brief overview of the project outlining how it specifically addresses the priority identified (please indicate if the project is a continuation of a previous or related ones) (300 words max). | | | | | | | | | | | | | |
| DFO’s Sustainable Fisheries Framework provides a foundation for implementing ecosystem-based fisheries management (EBFM) that can account for interactions among species and their environment (DFO 2017, GOC 2017).  There remains a critical need to establish tactical fishery management advice that is robust and ecosystem-responsive in order to make progress towards the essential goals of EBFM. A framework already exists and is widely applied in fisheries to obtain tactical management advice in the face of large uncertainty in system dynamics: Management Strategy Evaluation (MSE). It is a simulation approach that can formally test performance and robustness of management strategies for multiple plausible scenarios for ecosystems changes (operating models) including growth, survival and recruitment regime (Figure 1).  We propose an extension of ‘EcoTest’ to the open-source R package openMSE1 (Hordyk et al. 2022) to enable fitting of operating models including environmental covariates, the development and testing of ecosystem-responsive management strategies which includes auxiliary data collection, stock assessment models and harvest control rules. Additionally, the EcoTest extension will identify appropriate management reference points for stocks subject to ecosystem changes. Plausible changes to ecosystem dynamics will be tested in closed-loop simulation, to assess the risk of overfishing or overfished stocks using current management procedures (MP). If current MP cause fishery to be in decline, alternatives MPs will be tested. Where plausible ecosystem dynamics provide challenges across a range of management strategies, indicator systems will be investigated that can operate as a caution against proceeding with current management strategies.    This project will directly addresses the research priorities (FS-22-01): Incorporation of Environmental Variables into Stock Assessment and Science Advice: Developing and testing analytical approaches to facilitate the incorporation of environmental variables, i.e., climate, oceanographic and ecosystem factors, into stock assessment and science advice, including impacts on subsequent decision making.    Figure 1. EcoTest: robust fishery management advice for changing ecosystems. | | | | | | | | | | | | | |
| **8.2** **Addressing knowledge gaps** – Explain how this project advances knowledge, or addresses a knowledge gap among what is already published or available to clients. Use the references cited section below if needed. (300 words max). | | | | | | | | | | | | | |
| The current status quo approach to managing data-rich fisheries is to establish a stock assessment model that represents best available science and provide advice and project future stock status directly from that model. This approach to management advice assumes that the advice to fisheries management will be robust to ecosystem changes and that ecosystem changes are detectable.  However, climate change impacts as well as direct and indirect interspecific species interactions in the ecosystem pose a severe challenge to the ‘best assessment’ paradigm and are likely to preclude delivery under the timelines of Bill C-68 (DFO 2018). In order to address this key challenge, DFO has proposed to move from ‘best-model-oriented’ “study culture” to robust-management-oriented “decision culture”. MSE is a management-oriented framework ideally suited to this shift in focus and is able to test status quo and alternative management strategies for their responsiveness and robustness to a wide range of plausible ecosystem changes.  This proposal addresses DFO’s existing mandates to use scientific evidence, the precautionary principle, and take into account climate change when making decisions affecting fish stocks and ecosystem management (DFO, 2018). The proposed research improve science advice by incorporating more uncertainties, allowing fisheries managed to perform structured decision making.  This research aims to address the following critical knowledge gaps:   1. Do status quo management strategies provide acceptable performance given plausible ecosystem changes? 2. What are the key ecosystem changes that affect performance of status quo management strategies? 3. Can alternative management strategies such as management prescriptions (size limits, time-area closures), new assessments, harvest control rules based on alternative reference points that use auxiliary data, provide suitably responsive and robust advice? 4. Is it possible to establish indicators of these problematic ecosystem dynamics that can serve as an early warning system? | | | | | | | | | | | | | |
| **8.3 Objectives –** Describe the objective(s) of the project; you may chose to copy & paste those indicated in your LOI (200 words max). | | | | | | | | | | | | | |
| The overall aim of this project is to establish a tractable and rigorous approach for obtaining ecosystem responsive and robust tactical advice for fisheries managers consistent with the objectives of EAFM and EBFM.  This approach will be fully documented (including in the primary literature), reproducible, open-source and demonstrated for multiple case studies.  This project will directly address objectives of previous DFO EBFM working groups (e.g. DFO 2017):  1. Build expertise in EA/BFM  2. Evaluate existing management practices with respect to an EA/BFM.  3. Identify opportunities to incorporate EA/BFM.  4. Identify data gaps for ecosystem responsive management  5. Develop a plan to make progress with EA/BFM.  Additionally the project will  6. Build expertise in the technical aspects of MSE  7. Establish indicator systems that can detect problematic changes in dynamics  8. Investigate fishery management reference points that are appropriate given plausible changes in system dynamics  The selected case studies are focused on groundfish species, the approach can be applied to fisheries for other species group in the future. | | | | | | | | | | | | | |
| **8.4 Methodology –** Outline the methods you will use to achieve the objective(s) of the project (300 words max). | | | | | | | | | | | | | |
| The project consists of desk-based data processing, computer coding and report writing. All data and code for each case study will be shared on an appropriate platform (e.g. GitHub) among working group members. All new code for models, tools and figures will be fully documented and added to the open-source R package openMSE.  The project would focus on three case studies in the Maritimes region:  **1. 5Zjm Haddock.** Several ecosystem changes have been hypothesized for Haddock that could be included in robustness set operating models including density-dependent mortality, growth changes and recruitment regime shifts.  **2. 4X5Y Cod.** Key ecosystem considerations for Cod include historical and future impacts of increasing natural predation (e.g. seal) in addition to persistent changes in recruitment regime due to depensation.  **3. 4X5Y Haddock.** Important historical (and potentially future) changes in survival of older fish and somatic growth have been observed for Haddock that have implications for both reference points and performance of management strategies.  The project has three phases that correspond with each year of the project duration:  **Phase 1 (year 1). Case study operating models.** Establishes the working group, data and code sharing platform. Reference and robustness (including ecosystem changes) operating models are developed for each case study fishery.  **Phase 2 (year 2). Developing and testing management strategies.** Develop status quo management strategies for each stock (assessments, harvest control rules, reference points). Investigate and develop new alternative management strategies. Test the performance and robustness of all management strategies where applicable identifying any problematic ecosystem changes.  **Phase 3 (year 3). Indicators and presentation of results.** Develop indicator systems that can detect problematic ecosystem changes. Present results to stakeholders, managers and the wider scientific community at an appropriate venue. Draft at least one paper for publication in the primary literature summarizing the approach and findings. | | | | | | | | | | | | | |
| **8.5 Work plan** – Please use bullets to outline the main activities by fiscal year. | | | | | | | | | | | | | |
| **Year 1:** | * Establish a working group of experts including scientists and managers. * Establish a code and data sharing platform and a live project splash page including links to resources and progress updates. * Synthesize data (including ecosystem covariates) and characterize key uncertainties for the three case studies (5Zjm Haddock, 4X5Y Cod, 4X5Y Haddock). * the reference set conditional on data (conventional uncertainties) and robustness set (including ecosystem changes) operating models for each case study. | | | | | | | | | | | | |
| **Year 2:** | * Construct status-quo management strategies for each case-study * Develop alternative management strategies (assessments, harvest control rules, reference points) * MSE test the various existing and new management strategies and summarize results. * Identify best performing management strategies and identify problematic ecosystem dynamics. | | | | | | | | | | | | |
| **Year 3:** | * Develop indicators (e.g. multivariate time-series, A.I.) that provide suitable statistical power to detect problematic system dynamics (e.g. based on raw data or residual fit of models to data). * Summarize calculations and communicate these to managers. * Present results at an appropriate venue(For example, Maritimes Region EBFM working group meeting, Can./U.S. EBFM workshop and CSAS process). * Summarize approach and findings in a draft paper for publication in the primary peer-review literature. | | | | | | | | | | | | |
| **9. Data Management Plan** – Please use bullet points to complete this sections | | | | | | | | | | | | | |
| **9.1 Data Manager -** Identify who on the research team is responsible for stewarding the data throughout the project lifecycle (name, and their data stewardship role [e.g. collecting, analysing, storing, etc.]). Identify your Regional Data Manager (SDM-SC representative). Are they able to provide support for this project? (50 words max) | | | | | | | | | | | | | |
| * Tana Worcester, Regional Data data manager, is available for ad-hoc support/advice * Mike McMahon and Yanjun Wang are responsible for stewarding the data throughout the project lifecycle. | | | | | | | | | | | | | |
| **9.2 Data Acquisition –** Identify timeframes, geographic locations for acquiring data; identify resource requirements (instruments and equipment), outline any partnerships required (e.g. data sharing agreements, what MOUs might be in place, etc.). Point form preferred (100 words max) | | | | | | | | | | | | | |
| * Monica Finley and Caira Clark provide the bottom trawl survey and fishery data of the 3 groundfish species in the case study * Yanjun Wang is working with Maritimes Region Atlantic Zonal Monitoring Program (AZMP) group and NOAA ecosystem research ground to obtain environmental data on Georges Bank and Scotian Shelf | | | | | | | | | | | | | |
| **9.3 Processing and Analyzing –** Will raw instrument data be stored? What are your hardware/software needs? Will you require IM/TS support? What formats will the processed data be made available in (e.g. Excel, csv, access, R code)? (100 words max) | | | | | | | | | | | | | |
| * The data will be saved in Excel, with R code to input to R. | | | | | | | | | | | | | |
| **9.4 Data Preservation and Protection –** Provide information on data storage. How will physical samples be stored/tracked? What is the final destination (e.g. hard drive, desktop, enterprise database)? If data is not stored on DFO infrastructure, how will it be brought back inside the department? What will be the data maintenance cycle (frequency of data backups, etc.)? (150 words max) | | | | | | | | | | | | | |
| * No new data collection or storage is required in this project. * We are to compile existing data. * All created code will be open source through openMSE. | | | | | | | | | | | | | |
| **9.5 Data Publication** – What is the plan for making data available? Where will the data be openly published? How will proprietary / sensitive data be classified / handled? Point form preferred (150 words max) | | | | | | | | | | | | | |
| * The data will be become available to the public when published. * An appropriate platform (e.g. GitHub) can be used. | | | | | | | | | | | | | |
| **10. Project Outputs** | | | | | | | | | | | | | |
| **10.1 Deliverables** – Briefly describe the main project deliverables expected for each year of the work plan (be sure to include the mandatory ***final report*** on the results/outcomes for the clients). | | | | | | | | | | | | | |
| Year | | | Description | | | | | | | | | | |
| Year 1Year 1Year 1 | | | 1. Code sharing platform and centralized project hub for linking documentation, reporting progress and sharing code examples. 2. An operating model for each of the three principal case studies (5Zjm Haddock, 4X5Y Cod, 4X5Y Haddock) that synthesizes the current state of knowledge, including key system uncertainties and hypotheses including historical and future ecosystem changes. | | | | | | | | | | |
| Year 2Year 2Year 2 | | | 1. A codified version of the current status quo management strategy for each case study that can be tested for ecosystem-responsiveness and robustness. 2. Identification of appropriate management reference points and harvest control rules for ecosystem-ready management which may use auxiliary data. 3. A range of alternative stock assessments for use in population status evaluation and provision of advice. 4. Alternative management procedures for the case study stocks that may include auxiliary data (e.g. that make use of mean length of catches, fraction mature fish in catch etc). | | | | | | | | | | |
| Year 3Year 3Year 3 | | | 1. Design and testing of indicators of problematic ecosystem changes for use as an early warning system for each case study 2. Draft peer-reviewed paper for publication in the primary literature | | | | | | | | | | |
| Enter the year | | | 1. Describe the output | | | | | | | | | | |
| **11. Project Risk Management** – Please answer questions 11.1 – 11.3, and in the space below, briefly (i) **identify and assess** any risks for the project’s completion within the planned timeframe (e.g. COVID-19 restrictions, vessel availability, lab space, etc.), and (ii) **describe the mitigation measures** to prevent them (200 words max). | | | | | | | | | | | | | |
| **11.1** Does this project require **fieldwork?** | | | | | | | | | | Yes  No | | | |
| **11.2** Does this project require **High Performance Computing** **(HPC)?** (if yes, complete the HPC questionnaire, if no, delete the HPC questionnaire page from your application) | | | | | | | | | | Yes  No | | | |
| **11.3** Have you applied for funded **ship time** under the CCG ship time call out for this project? | | | | | | | | | | Yes  No  N/A | | | |
| Dr. Thomas Carruthers is the lead of openMSE R package develop team, and currently under contract with DFO on one of the case study fish stock 5Zjm haddock framework modelling. His expertise and working experience with Maritimes fishery Science will ensure this research project completed within the planned timeframe. | | | | | | | | | | | | | |
| **12. Budget:** Outline funding requested from the CSRF for the applicable years. Please **use budget spreadsheet** on the SFS website to ensure accurate calculation \*\****Round to the nearest dollar***. | | | | | | | | | | | | | |
| **12.1 Salary requirements** | | | | **Year 1** | **Year 2** | | | **Year 3** | | | | | **Total** |
| **Casual Employees** | | | | $ | $ | | | $ | | | | | **$** |
| **Post-doc hires** | | | | $ | $ | | | $ | | | | | $ |
| **FTE salary** (be sure to include EBP) | | | | $ | $ | | | $ | | | | | **$** |
| **Salary Subtotals** | | | | **$** | **$** | | | **$** | | | | | **$** |
| **Detail of salary costs:**  Please provide a clear breakdown of salary requirements in the space below (year, amount, what for, for which region): | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| **12.2 O&M requirements** | | | | **Year 1** | **Year 2** | | | **Year 3** | | | | | **Total** |
| **Student Salary** | | | | $ | $ | | | $ | | | | | $ |
| **Contract(s)** | | | | $80,000 | $80,000 | | | $80,000 | | | | | $240,000 |
| **Materials & Supplies** | | | | $  $$  $$ | $  $$  $$ | | | $  $$  $$ | | | | | $  $$ |
| **Equipment –** cost of purchase or rental | | | | $ | $ | | | $ | | | | | $ |
| **Equipment –** operating / maintenance cost | | | | $ | $ | | | $ | | | | | $ |
| **IT Costs** - Hardware and software(incl HPC) | | | | $ | $ | | | $ | | | | | $ |
| **IT Costs -** Data storage | | | | $ | $ | | | $ | | | | | $ |
| **Vessel costs** | | | | $ | $ | | | $ | | | | | $ |
| **Publication/printing fees, open access fees** | | | | $ | $ | | | $ | | | | | $ |
| **Translation expenses** | | | | $ | $ | | | $ | | | | | $ |
| **Travel** | | | | $  $$  $$ | $  $$  $$ | | | $  $$  $$ | | | | | $  $$ |
| **Other** | | | | $  $$  $$ | $  $$  $$ | | | $  $$  $$ | | | | | $  $$ |
| **O&M Subtotals** | | | | $ | $ | | | $ | | | | | $ |
| **Combined Subtotals:** | | | | $ | $ | | | $ | | | | | $ |
| **Overhead** (combined subtotal x .% overhead) | | | | $12,000 | $12,000 | | | $12,000 | | | | | $36,000 |
| **Project Totals:** | | | | $92,000  **$$**  **$$** | $92,000  **$$**  **$$** | | | $92,000  **$$**  **$$** | | | | | **276,000$**  **$$** |
| **Detail of O&M costs**  Please provide a breakdown for line items below, detailing specific expenses (year, amount, what for, which region). | | | | | | | | | | | | | |
| **Student Salary** | | | |  | | | | | | | | | |
| **Contract(s)** | | | | 2022-2024: $80k each year for service contact, Maritimes | | | | | | | | | |
| **Materials & Supplies** | | | |  | | | | | | | | | |
| **Equipment** | | | |  | | | | | | | | | |
| **IT costs** | | | |  | | | | | | | | | |
| **Vessel costs** | | | |  | | | | | | | | | |
| **Publication/printing** | | | |  | | | | | | | | | |
| **Translation expenses** | | | |  | | | | | | | | | |
| **Travel** | | | |  | | | | | | | | | |
| **Other** | | | |  | | | | | | | | | |
| **12.3 Other sources of funding -** Identify possible other sources of funding (program or institution), type (cash/in kind) and amount of additional funding/support you would need (if applicable). | | | | | | | | | | | | | |
| 1. | | | | | | | | | | | $ | | |
| 2. | | | | | | | | | | | $ | | |
| 3. | | | | | | | | | | | $ | | |
| **Total amount from other funding sources:** | | | | | | | | | | | **$** | | |
| **Definitions:**  Cash contribution: funding received by accountable project manager to finance the activity. The funding can come from within DFO or transferred from external partners.  In-kind contribution: A contribution of goods/supplies, services, and/or time (from external collaborators) that does not involve the transfer of money. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| **13. References cited** | | | | | | | | | | | | | |
| 1 The packages DLMtool and MSEtool that are included in openMSE were previously supported by DFO’s Ocean and Freshwater Science Contribution Program, MECTS-#3688308, MECTS-#3802462, MECTS-#4171361).  DFO. 2017. Maritimes Region Workshop Report: Incorporating an Ecosystem Approach into Science Advice for Fisheries (April 3 to 7 2017). Available at: <https://waves-vagues.dfo-mpo.gc.ca/Library/40636914.pdf>  DFO. 2018. Mandate and Role. Last updated 2018-08-28. Available online at: http://www.dfo-mpo.gc.ca/about-notre-sujet/org/mandate-mandat-eng.htm  GOC. 2017. Minister of Fisheries, Oceans and the Canadian Coast Guard Mandate Letter. Available at: https://pm.gc.ca/en/mandate-letters/2019/12/13/archived-minister-fisheries-oceans-and-canadian-coast-guard-mandate  Hordyk, H., Huynh, Q., Carruthers, T. 2022. openMSE: an R package is designed for building operating models, doing simulation modelling and management strategy evaluation for fisheries. Available at: www.openmse.com | | | | | | | | | | | | | |

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| **High Performance Computing (HPC) Requirements Information Page**  Please complete this page if your project requires HPC.  *If you do not have HPC requirements, you may delete this page before submitting your application.* | |
| **1. Computing Requirements:** (# of Core hours per month for the required amount of time (e.g., 6000 core hours per month for 8 months) by fiscal year |  |
| **2. Status:** Is this ongoing work or new (if ongoing please include how much HPC has been used in the last year) |  |
| **3. Timing (i):** Timing of planned modelling work (i.e., when is this planned for? E.g., for 9 months starting in April 2022) |  |
| **4. Timing (ii):** Do you plan on using resources during historically light periods (i.e., overnight, in the summer, winter break etc.) |  |
| **5. Contingency Plan:** If there is very limited HPC access after March 2022, how will you complete the necessary modelling andanalysis? |  |
| **6. Storage Needs (i):** How much storage do you require (in TB)? |  |
| **7. Storage Needs (ii**): GPSC storage CANNOT be used long term (i.e not for longer than a few months) – what is your plan for longterm storage? |  |
| **8. Storage Needs (iii):** What is your plan for archiving your data (i.e how often will you move and delete your runs – will it be done automatically?) |  |
| **9. Software Requirements:** Do you need access to proprietary software (i.e. Matlab)? |  |