# WORKSHOP ON GRADUATE/POST GRADUATE EDUCATION STRATEGY TO MEET FUTURE ICES ADVISORY NEEDS (WKEDU; OUTPUTS FROM THE 2020 MEETING)

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# Contents

# i Executive summary

The Workshop on Graduate/Post Graduate Education Strategy to Meet Future ICES Advisory Needs (WKEDU) was convened as part of the Council Strategic Initiative considering resource availability for the ICES Advisory Process (CSI Resources). A proposal was developed to support a strategy for long-term capacity building through graduate education. This will involve coordination among North American and European Universities to develop multi- and trans-disciplinary, multi-institutional coursework, research opportunities and scientific personnel exchanges that will build capacity (through graduate- and post-graduate education) for meeting future ICES science-based advisory needs.

# ii Expert group information

| | |
|---|---|
| **Expert group name** | Workshop on Graduate/Post Graduate Education Strategy to Meet Future ICES Advisory Needs (WKEDU) |
| **Expert group cycle** | Annual |
| **Year cycle started** | 2020 |
| **Reporting year in cycle** | 1/1 |
| **Chair** | William Karp, United States |
| **Meeting venue(s) and dates** | 30 November – 3 December, online (43 participants) |

# 1 Introduction

## 1.1 Terms of Reference

Workshop on Graduate/Post Graduate Education Strategy to Meet Future ICES Advisory Needs (WKEDU) was chaired by William (Bill) Karp, Steve Cadrin, and Tim Essington.

As one strand in a broader Council Strategic Initiative to address questions and concerns regarding processes within member countries to ensure that resources are available to support the ICES Advisory Process (CSI Resources) a proposal was developed to support develop a strategy for long-term capacity building through graduate education. This will involve coordination among North American and European Universities to develop multi- and trans-disciplinary, multi-institutional coursework, research opportunities and scientific personnel exchanges that will build capacity (through graduate- and post-graduate education) for meeting future ICES science-based advisory needs. To further this initiative, WKEDU convened remotely 30 November – 2 December 2020, to address the following Terms of Reference:

1) Summarize expertise required to meet current advisory needs and identify likely future expertise requirements for providing advice that supports ecosystem-based decision-making for the management of human activities in marine ecosystems.

2) Evaluate opportunities and impediments related to building interdisciplinary, multi-institutional, international graduate/post graduate programs (while the primary focus is to address future ICES advisory needs, broader capacity building needs should also be taken into account)

3) Review/summarize current single- and multi-institutional programs that support needs identified above and identify successful models

4) Identify issues that must be resolved to allow this initiative to move forward, describe next steps and a draft a roadmap for developing a curriculum within 3 years

5) Describe/propose a process for accomplishing these TORs, including possible formation of an expert group and further workshops

6) Evaluate and incorporate approaches for improving (post) graduate education opportunities for women, underrepresented minorities, indigenous people and fishers through this initiative

Funding has been provided for follow up activities from the US and from an ICES strategic investment.

## 1.2 Background

In recent years, ICES has been experiencing increasing demands for advice, especially related to *ad-hoc* Advice requests and associated working groups. In order to meet these demands, a well-trained work force and experts with the necessary skills and competences are required The ICES Advisory Plan, https://issuu.com/icesdk/docs/ices_advisory_plan, provides a good overview of the scope of ICES advice. The requests for advice come from established international and national Clients and, increasingly also from new sources such as national environmental agencies or arising from coastal states' agreements.

### 1.2.1 Skills and competences relevant for ICES advice

ICES must ensure that our advice is resilient to quality demands and complexities of ecosystem-based management. Advice must be credible, legitimate, and salient and integrate fisheries and ecosystem advice, while also remaining consistent across a broader set of requesters and sectors.

ICES has established ten principles within its advisory framework and many of these principles relate directly to maintaining and building expert capacity:

> Principle 1. The guidelines and procedures to produce ICES advice are documented, openly accessible, and up-to-date.
>
> Principle 2. Final request formulation is agreed through dialogue to clarify the requester's needs and expectations, the ICES process, likely resource implications, timelines, format of advice, and roles and responsibilities of the engaged parties.
>
> Principle 3. Where possible, existing policy goals, objectives, and the level of acceptable risk relevant to the advice request are identified. Where these objectives and descriptions of risk are unclear, ICES will identify these in the advice, and, where possible, provide options for management action and the consequences of the options and their trade-offs.
>
> Principle 4. The deliberations of all relevant expert groups are published by the time the associated advice is published.
>
> Principle 5. The best-available science and quality-assured data are used. ICES selects and applies relevant methods for any analysis, including the development of new methods. The methods are peer reviewed by independent experts and clearly and openly documented.
>
> Principle 6. Data are findable, attributable, researchable, reusable, and conform to ICES data policy. Data flows are documented.
>
> Principle 7. To ensure that the best available, credible science has been used and to confirm that the analysis provides a sound basis for advice, all analyses and methods are peer reviewed by at least two independent reviewers. For recurrent advice, the review is conducted through a benchmark process; for special requests through one-off reviews.
>
> Principle 8. Advice is comprehensive, unambiguous, and consistent with the synthesized knowledge, while taking the peer review into account. All advice follows existing advice frameworks and any deviation from the frameworks or related, previous advice is identified and justified
>
> Principle 9. All ICES advice is adopted by the ICES Advisory Committee (ACOM), through consensus, prior to being made available to the requester and simultaneously published on ICES website.
>
> Principle 10. ICES provides advice as an impartial response to a request, and does not lobby the requester or any other party to implement its advice.

Some specific needs for expertise have been recognized. These include: management strategy evaluation in the broader sense (and not just fisheries); mixed fisheries, fleet dynamics & spatial analysis; management approaches in data limited situations; stakeholder engagement and dialogue; and bycatch evaluation and mitigation measures.

Current and future advisers should also possess skills such as: enhanced communication capabilities; ability to work with qualitative and quantitative information; teamwork and collaborative skills; understanding of science-based decision-making; and a willingness to challenge existing paradigms.

## 1.3 In advance of the meeting

In preparation for the meeting, feedback was requested from meeting participants, ICES Delegates (member country representatives), and advice requesters.

### Meeting Participants

Representatives from academic institutions participating in WKEDU were asked to provide feedback on available education and training opportunities, as well as future needs. Nineteen responses were received, and these are detailed in Section 2.

### ICES Delegates

Feedback from ICES Council Delegates on their needs and expectations related to the skills and training needed was collected. In this survey, questions related to the technical needs and ability to find qualified individuals to support ICES. Questions about current activities, future activities, and associated needs were also provided. Ten responses were received from eight member countries.

Responses highlighted issues related to timing, and funding models. Future needs and gaps identified included: Modelling (applied mathematics); fish stock assessment; big data; database management; integrative/interdisciplinary research, and ecosystem approaches.

### Advice Requesters

Feedback from ICES Advice Requesters was also requested. This focused on needs and expectations related to the skills and education required for the science that facilitates the production of the impartial evidence on the state and sustainable use of our seas and oceans.

The survey included questions about the technical needs and ability to find qualified individuals to support ICES. The survey consisted of three main questions, about experiences and perceptions of the availability of the expertise required to respond to requests for ICES Advice.

Four responses were received. These indicated that overall request responses have been satisfactory even though occasional delays in provision of advice were noted. Advice requestor responses stressed the growing need for skills to support interdisciplinary and ecosystem approaches advice requests. Responses to a question about diversity were ambiguous, perhaps indicating poor phrasing of the question.

## 1.4 Conduct of the meeting

Forty-three participants gathered remotely over three days to engage through presentations, breakout sessions, and plenary discussions.

On the first day, representatives from educational institutions were invited to provide short presentations with focus on current program content and perspectives on future needs, mirroring survey responses. An overview of the issues highlighted is provided in Section 2 of this report.

During breakout sessions on the second day, groups were asked to discuss and report back on elements that should be included in a curriculum, including core requirements as well as electives/areas of specialization. As time allowed, they were asked to consider the other TORs as well as next steps for the WKEDU initiative. On the third day, in plenary session, breakout session summaries were presented, and participants discussed topics raised including:

Issues and suggestions articulated during these deliberations are summarized below, organized under the workshop's TORs:

1. Summarize expertise required to meet current advisory needs and identify likely future expertise requirements for providing advice that supports ecosystem-based decision-making for the management of human activities in marine ecosystems.

**Current and likely future needs**

(Informed by presentation from Mark Dickey-Collas, ACOM Chair)

- Quantitative Stock Assessment
- Quantitative approaches more broadly
- Social Science, Inter and transdisciplinary expertise
- Engineering & ecology

**Specific current needs identified by ACOM**:

- management strategy evaluation in the broader sense (not just fisheries);
- mixed fisheries,
- fleet dynamics & spatial analysis;
- management approaches in data limited situations;
- stakeholder engagement and dialogue;
- bycatch evaluation and mitigation measures.

**Importance of flexibility and ability to adapt to changing needs** (Skillset Portfolio identified by Mark Dickey-Collas):

- Analytically competent/innovative
- Degree of human engagement skills
- Awareness that knowledge is not only quantitative
- Team work, dialogue, listening
- Awareness of issues around science informed societal decision-making
- Challenging existing paradigms

2. Evaluate opportunities and impediments related to building transdisciplinary, multi-institutional, international graduate/post graduate programs (while the primary focus is to address future ICES advisory needs, broader capacity building needs should also be taken into account)

**Opportunities**

- Needs cannot be satisfied by one institution; some institutes are better fit to some skills than others. A cross-reference guide could be developed to encourage cooperation/collaboration.
- Potential shorter-term possibilities and alternatives to explore:
  - Summer schools
  - Sharing existing courses across institutions
  - Shared mentoring/advising of students
  - Consider potential for "ICES accreditation" of programs/courses and linkage to agency needs

- Consider potential for ICES certification of experts

**Impediments**

- Structural difference between North American and European grad programs

3. Review/summarize current single- and multi-institutional programs that support needs identified above and identify successful models

Detailed information on individual programs were provided by participants through survey and presentations (see Section 2 for more information)

**Multi-institutional programs include**:

- Marine Alliance for Science and Technology Scotland (MASTS) and The Scottish Universities Partnership for Environmental Research (SUPER)
- Fellowships joint funded by NOAA Fisheries and National Sea Grant Program (USA), supporting PhD students studying population and ecosystem dynamics and resource economics.
- ERASMUS/ERASMUS+
- Living Marine Resources Cooperative Science Center: NOAA-supported program across seven academic institutions designed to train and entrain underrepresented communities into NOAA and other marine science careers.

4. Identify issues that must be resolved to allow this initiative to move forward, describe next steps and a draft a roadmap for developing a curriculum within 3 years (overlap with TOR 2)

**Issues to resolve:**

- Funding
- Academic credit and degree requirements equivalence
- Balance between breadth and depth (related to differences between NA and European graduate programs)
- Linkage with undergraduate programs
- Process for addressing deficiencies/gaps in undergraduate programs
- Establishing minimum requirements
- Definition of terms including multidisciplinary and transdisciplinary

**Ideas for curriculum/program content** (requires further consolidation)

- Core Competencies - balancing between broad education and specialised skills.
- Creative thinking, innovation, problem solving as essential skills/core competencies
- Engage students with real problem solving by linking ICES needs and questions to universities needs for problem activities, i.e. provide students with direct opportunities to experience ICES work.
    - E.g. [Formally] distribute benchmark worklist to partner Higher Education Institutes [although nothing to stop participants distributing as is, but just hard to find online].
- Students would most likely be supervised by university profs, but their research projects would directly relate to ICES needs. Exposes students to scientists. Idea is not to burden ICES or local institutes.

**Suggested basic/core subject matter requirements**

- Fisheries Ecology and Biology and Aquaculture
- Natural resource economics, anthropology, and geography

- Biological Oceanography, climate impacts on aquatic systems
- Inclusive and equitable science

**Potential electives/areas of specialization**

- Ethics
- Law
- Policy
- Moderation and facilitation, conflict resolution, reasoning, diplomacy
- Decision Analysis (including Management Strategy Evaluation and Risk Management)
- Environmental Impact Assessment
- Intercultural competence
- Stock assessment and modelling

**Relevant Activities**

- National Lab placement
- Sending students to assessment group meetings and advice drafting groups
- Consider partnerships in educating students (e.g. ICES/industry/NGOs/National Laboratories)
- consult with past students on relevant experiences.

5. Describe/propose a process for accomplishing these TORs, including possible formation of an expert group and further workshops

- It was agreed to propose a 3-year working group (see draft TORs below)
- A remote meeting is planned for spring 2021 to fine-tune TORs and workplan
- First full meeting (Late 2021)

6. Evaluate and incorporate approaches for improving (post) graduate education opportunities for women, underrepresented minorities, indigenous people and fishers through this initiative:

- Consider establishing mentoring programmes for underrepresented groups
- Consider funding for participants which takes into account gender equality
- More voices needed at the table for this issue; be more conscious when organizing future workshops
- Women are well represented in academic institutions, but retention, and representation at more senior levels still problematic.
- Short and longer term actions should be considered for women, potentially groups (participation in existing networks)/special grants. Recruit greater diversity/flexibility/inclusion, peer-to-peer mentorship. Retention must consider career development and personal capacity.
- An aim should be to create spaces where people feel included/empowered, make opportunities that allow people to that. Need money to support participation.
- Encourage greater diversity of participation as working group moves forward.

## 1.5 Next Steps

Workshop participants seek approval to establish a working group (WGEDU). Draft TORs are provided below. The first (online) meeting of the new WG would be in April 2021, primarily to fine-tune TORs and agree on a work plan (three years). First full meeting would occur in late 2021.

### Proposal for Working Group on Graduate/Post Graduate Education Strategy to Meet Future ICES Advisory Needs

Draft Terms of Reference (Bill Karp – January 2021)

WGEDU will meet online in June, 2021 to advance the process of planning and developing a curriculum by reviewing and updating the following Terms of Reference (TORs) and developing a workplan to address these TORs:

1) Evaluate opportunities and impediments related to building interdisciplinary, multi-institutional, international graduate/post graduate programs (while the primary focus is to address future ICES advisory needs, broader capacity building needs should also be taken into account). Specific considerations should include (but not be limited to):
    a. Funding
    b. Academic credit and degree requirements equivalence
    c. Balance between breadth and depth (related to differences between NA and European graduate programs)
    d. Linkage with undergraduate programs
    e. Process for addressing deficiencies/gaps in undergraduate programs
    f. Establishing minimum requirements
    g. Structural difference between NA and EU grad programs
2) Further review current models for inter-and trans-disciplinary, multinational graduate programs and propose a structure for this program (need to consider funding, etc. here)
3) Develop and establish a curriculum which emphasizes core competencies, defines required and elective coursework, offers cross-institutional research and mentoring opportunities (need to expand on this)
4) Consider and develop recommendations regarding alternative approaches for educating experts including:
    a. Summer schools
    b. Sharing existing courses across institutions (short-term)
    c. Shared mentoring/advising of students.
    d. Potential for "ICES accreditation" of programs/courses and linkage to agency needs
    e. Potential for ICES certification of experts

5) Evaluate and incorporate approaches for improving (post) graduate education opportunities for women, underrepresented minorities, indigenous people and fishers through this initiative (need to update this language)
6) Consult broadly with agencies, universities, early-career professionals, etc. to ensure the program will be inclusive and address current and future needs.
7) Coordinate with other programs with similar objectives and seek synergies as appropriate

# 2 Participant and university presentations

## 2.1 Miachaela Aschan, UiT The Arctic University of Norway, Faculty of Bioscience, Fisheries and Economics

| | |
|---|---|
| Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems? | Yes |
| Approximately how long do students take to complete the programme? | 2 years for MSc. / 3 years for BSc. |
| Approximately how many students graduate annually? | 90 |
| Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers? | 15% |
| Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems? | 1 |
| Approximately how long do students take to complete the programme? | 4 years |
| Approximately how many students graduate annually? | 6 |
| Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers? | 20% |

| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
|---|
| Multidisciplinary: knowledge of management systems and sciences; Science communication; Contact with stakeholders; Trained to work independently and in teams<br>• Arctic marine ecology, population biology, gear technology, and marine governance, including spatial planning, transferable skills (communicating science, applying for funding, etc. )<br>• Good infrastructure, library services, rooms labs,<br>• Good cooperation with IMR, Nofima, etc in Norway – who often host our PhD students<br>• Have a few H2020 projects relevant for fisheries, i.e. DocEnhance which provides training and networking . |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| • In depth stock assessment modelling competence; Establish European program on latest tools in stock assessments<br>• Multidisciplinary and good social sciences involved and we would like to strengthen in stock assessments and provide training in this<br>• Low mathematical and statistical skills among Norwegian students |

| |
|---|
| • Exchange of students low and little Norwegian students going out<br>• Engagement with ICES in ICES WGs and internships on ad-hoc basis |
| **Please explain how your institution collaborates with other educational institutions:** |
| Erasmus student exchange on all master programs; Exchange of lecturers and Prof II positions (10-20%) from other universities and the institute sector (e.g. Marine Research Institute, Norway and Nofima) |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Now equally qualified for a PhD position the minority representative or female should be chosen (in case of a male dominated research group). There is a female dominance among PhD students at the faculty. |
| **Other comments on advancing this initiative** |
| 1) Facilitate student exchange 2) Online training in quantitative assessment combined with local PC labs and workshops on master and PhD level |

## 2.2 Tim Essington, University of Washington

| | |
|---|---|
| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 3 years |
| **Approximately how many students graduate annually?** | 5-10 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 50% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 5 years |
| **Approximately how many students graduate annually?** | 5-8 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 50% |

| |
|---|
| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Our strengths are in population dynamics, stock assessment, ecological modelling and decision analysis. Many of the students participate as interns in science working groups providing advice to the managers. Engagement with decision makers and collaboration with NOAA fisheries, eNGOs and fishing industry. Proximity to two NOAA science centres is an advantage. |

| |
|---|
| Other strengths in: governance training, fisheries economics, fisheries and biological oceanography, data limited fisheries and assessment, anthropology and other social sciences, population genetics and genomics, inter and multidisciplinary science |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| Theory (And practice) of stakeholder engagement; transdisciplinary research; local and indigenous knowledge partnerships/co-production of knowledge; and no course offerings in the management process. |
| **Please explain how your institution collaborates with other educational institutions:** |
| We have exchanges with a number of universities, mostly students from other places coming to UW for specialized training in stock assessment methods |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Our masters and Ph.D. students are 65% women, we have identified a range of activities to help recruit underrepresented groups and are just beginning to implement them. These efforts include: partnering with NOAA, recruitment scholarships to talented individuals who otherwise wouldn't have access to education; holistic graduate admission review; implementation of active learning and training of faculty; and equity and inclusion committee. |
| **Other comments** |
| |

## 2.3 Anders Nielsen, Danish Technical University, DTU Aqua

| | |
|---|---|
| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 3 years |
| **Approximately how many students graduate annually?** | |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 3 years |
| **Approximately how many students graduate annually?** | 5 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 2 |

| |
|---|
| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Quantitative skills (and specialisation in stock assessment), rigorous statistical foundation, tools to implementing statistical models, developing and applying assessment models, collaboration with ICES and teaching, close connection to advice process, oceanography, genetics |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| Entry level is very diverse, which is a challenge. |
| **Please explain how your institution collaborates with other educational institutions:** |
| Aqua is part of DTU and collaborate with other DTU institutes, also via the advice process in ICES, and giving and taking ICES training courses. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| I think less than 50% of postgraduates are men, but I have not checked. There are efforts "woman groups" where younger women are advised on how to move up to higher positions. |
| **Other comments** |
| In advancing this initiative, need to collaborate across universities, map out educations that will feed into the initiative, first, define what competences are needed and then design courses and educations based on these competences. |

## 2.4 Francis Neat, World Maritime University (WMU) –Post graduate research at WMU and the Sasakawa Global Ocean Institute

| | |
|---|---|
| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 14 months |
| **Approximately how many students graduate annually?** | 120 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 10% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 3-4 years |
| **Approximately how many students graduate annually?** | 2 |

| | |
|---|---|
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 10% |

| |
|---|
| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Trans-disciplinary approach combing social and natural science. Research themes and expertise relevant to ICES: science-policy interface of noise from shipping, ballast water control and invasive species, interface between maritime safety, working conditions and fisheries, climate change and shipping emissions, ocean warming and deoxygenation, gender studies in the maritime sector, Marine Environmental Impact Assessment.<br><br>The masters specialisation and PhD programmes are programmes designed for global capacity building for developing country mid-career professionals in maritime administration. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| Need to strengthen application of quantitative methods to research |
| **Please explain how your institution collaborates with other educational institutions:** |
| Exchange programmes, Co-supervision of students with other institutes, visiting lecturers. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| WMU has a unique recruitment of students mainly from the developing world and thus has a remarkably diverse global cross section of cultures and people. Gender equality is among its highest priorities and a research theme in itself. Women are especially well represented in the PhD programme. |
| **Other comments** |
| |

## 2.5 Paul Fernandes, MASTS/Aberdeen –Marine Alliance for the Science and technology of Scotland

| | |
|---|---|
| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 1 year |
| **Approximately how many students graduate annually?** | 15-25 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 25% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |

| | |
|---|---|
| **Approximately how long do students take to complete the programme?** | 3-4 years |
| **Approximately how many students graduate annually?** | 3 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 75% |

| |
|---|
| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| The only fisheries specific MSc in the UK (and probably Europe), with significant contributions from government scientists (Marine Scotland Science). Opportunities for research with government scientists and access to research vessels. Specific courses in stock assessment, acoustic surveys, and GIS. Strong numerical component, with training in statistical modelling and programming in R. Recent diversification now includes a marine conservation MSc as an alternative to the historic fisheries focus.<br><br>MASTS graduate school includes: annual retreat for all PhD students, specialist training and workshops, collaborative PhDs, internships, fellowships and exchanges and academic bridge to MASTS Woods Hole in the US. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| 1 year masters as per UK standard, seen as limited training compared to some European and North American universities. Limited time for research project (2/3 course work). 2 year masters with placement year being considered. |
| **Please explain how your institution collaborates with other educational institutions:** |
| We have jointly funded PhD programmes (MASTS with SUPER; Queens University Belfast & ABFI with Quadrat) and through that or with other schemes, many of our PhD students are based in government research institutes such as Marine Scotland Science. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Women make up the majority of our marine MSc programmes already. PhD are more balanced in terms of gender. International students make up a steady but small proportion of our MSc & PhD intake, however this may change with Brexit. Fishers have participated on occasion, but it is rare and usually they have retired or looking to change. |
| **Other comments** |
| |

## 2.6 Sieglinde Gruber EU DGRTD – European Commission, healthy oceans and seas initiative

| |
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| **Please explain how your institution collaborates with other educational institutions:** |
| The European Commission puts a lot of focus on integrating training as PhD in impact projects and would like to continue to give the opportunity to graduates to be involved in multi- |

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| disciplinary projects. At the moment, DGRTD is working with Erasmus+ to launch a Blue Erasmus programme and allow people to move around within the context of Erasmus. |
| **Other comments** |
| DGRTD is focusing on graduate training, especially for future talent management in the blue economy. The pandemic has also shown us the need to rethink curricula for training graduates and the need to integrate digital skills such as artificial intelligence, machine learning. This will impact future graduate programmes.<br><br>Recommend the publication on European Marine Board on the landscape of marine education in Europe and how to store the information presented in WKEDU so that we can learn from each other. |

## 2.7 Anya Waite, Ocean Frontier Institute (OFI), Canada – Ocean Graduate Excellence Network (OGEN)

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| OGEN is becoming a national programme in Canada that provides transdisciplinary training with partners from industry and government. The programme focuses on research beyond academia due to its broad employment reach, supporting societal needs, communicating research benefits to non-academic stakeholders, collaboration with industry and government, multidisciplinary. The programme gives students a full-spectrum experience through internships at different government levels, entrepreneurship training, indigenous cultural training in ocean literacy, practical skills at sea and workshops and summer schools. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Indigenous cultural training engages indigenous communities in providing training for researchers in ocean literacy and in engagement. |

## 2.8 Strathclyde University – Dougie Speirs, Marine Population Modelling Group, Department of Mathematics and Statistics

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Harnessing of mathematics and statistics to solve some of the new challenges facing natural resource management, scientific tools (models and web browser applications) that are unique, high resolution hydrodynamic simulations (digital tidal stream atlas, spatial mapping of tidal energy resources, effects of structures on sediment transport), and knowledge exchange and professional development in state-of-the-art modelling and mathematical methods applied to environmental sciences |

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| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
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| **Please explain how your institution collaborates with other educational institutions:** |
| Linked to Scottish Government, UK Natural Environment Research Council, SUPER Doctoral Training Partnership, UK Engineering and Physical Sciences Research Council, EU H2020 Programmes and academic links in UK, Europe, USA and Canada |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
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| **Other comments** |
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## 2.9 Jan Jaap Poos, Wageningen University and Research

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| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2 years |
| **Approximately how many students graduate annually?** | 10-100 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 25-50% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 4-5 years |
| **Approximately how many students graduate annually?** | 5-50 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 50% |

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Multidisciplinary curricula for MSc students with a main programme in aquaculture and marine resources and several tracks within the main programme. The MSc programme combines general courses and workshop/academic consultancy training in issues from real advisory clients. Combining research thesis with internship at institution of choice for MSc students. Close links with national fisheries lab. PhD students are related to several ICES domains in aquaculture and fisheries, marine animal ecology, environmental policy group and environmental economics and natural resources group. |

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| Opportunity to expand knowledge domains in aquaculture and social sciences working on marine governance and economics, and collaboration with "traditional fisheries ecologists." |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| Extending number of MSc courses on advanced quantitative ecology |
| **Please explain how your institution collaborates with other educational institutions:** |
| Through national platform for technical universities |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
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| **Other comments** |
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## 2.10 Etienne Rivot, L'instut Agro, Agrocampus Ouest, Master program Fisheries and Aquaculture Sciences

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| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2 years |
| **Approximately how many students graduate annually?** | 15 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 30% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 3.5 years |
| **Approximately how many students graduate annually?** | 3 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 75% |

| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
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| • Strong quantitative skills (modelling, statistics, programming)<br>• A multidisciplinary programme to provide a large vision of environmental/economic issues<br>• Students have strong connections with research institutes (Ifremer, IRD, INRAE) during the programme |

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| • Programme is designed to train high level executives, not only for research but in different types of organizations within fisheries<br>• Well established programme with strong visibility and network in academic institu-tions, professional organizations in fisheries and aquaculture, and governmental and stakeholder organizations. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| • Improve international connections (e.g. improving exchanges with research institutes abroad)<br>• Develop learning by research activities (too many courses, not enough learning by research activities)<br>• Develop new pedagogy in online courses and active learning<br>• Finding the appropriate balance between multidisciplinary and specialised courses<br>• Need to strengthen connections with academics in social sciences |
| **Please explain how your institution collaborates with other educational institutions:** |
| Our Master programme is co-led by Institut Agro and the University of Britany, France. An international exchange PhD program exists with the Fisheries Center of the University of British Columbia, Vancouver, Canada. Students are strongly encouraged to develop their Masters thesis and PhD projects abroad. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Women already represent >50% of the Master Programme |
| **Other comments** |
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## 2.11 Margarida Castro, University of Algarve

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|---|---|
| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2 years |
| **Approximately how many students graduate annually?** | 15 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 3-4/15 |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 4-6 years |
| **Approximately how many students graduate annually?** | 10 |

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| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | Considering the fisheries area (1-2 per year) 100% |

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Strong link to research projects and practical work (including course work). Quite a number of elective courses where students can choose practical work in private sector, university and organizations. Strong emphasis on experimental work and links to aquaculture industry. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| The critical point is the lack of interest in fisheries science. Most students are more interested in aquaculture, conservation and end up working for NGOs.<br><br>Hope to integrate other scientific field and create a more diverse recruitment. Challenge to include areas of expertise that are not considered in fisheries programmes (political science, conflict management, history, ethics). |
| **Please explain how your institution collaborates with other educational institutions:** |
| Students are free and encouraged to develop their thesis outside, many through contacts or project partners from ualg or ccmar researchers. The teachers, whenever a speciality is not covered by our researchers, are recruited from the outside and end up supervising thesis and collaborating with us (such as in resource economics, social issues applied to fisheries, management, law and governance among others) |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Most of our students are females. We never engaged in those kinds of programs |
| **Other comments** |
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## 2.12 Steve Cadrin, University of Massachusetts Dartmouth, School for Marine Science & Technology

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|---|---|
| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2 years |
| **Approximately how many students graduate annually?** | 10 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 75% |

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| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 5 years |
| **Approximately how many students graduate annually?** | 5 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 75% |

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Integration of fieldwork, collaboration with fishers, quantitative analysis and policy relevance. High quality students with 100% job placement in fisheries; facilities are state-of-the-art and located in the number one fishing port in the US; successful federal grants and partnerships. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| • Student funding and low enrolment in the program – many students apply, but too few are funded by research grants<br>• Do not have faculty in social sciences, marine governance and policy<br>• Largely an undergraduate program<br>• Limited number of faculty available for advising |
| **Please explain how your institution collaborates with other educational institutions:** |
| Grants, publications and student mentoring |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Internships for underrepresented groups |
| **Other comments** |
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## 2.13 Mary Wisz, Mission Atlantic

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| **Other comments** |
| The Mission Atlantic project has a capacity building work package, led by Mary Gassala from the University of Sao Paolo and Mary Wisz, World Maritime University. One of the tasks part of this work package is to identify the cross-disciplinary skillset that are needed to support integrated ecosystem assessments.<br><br>A workshop will be planned for November 2021 to identify skillsets that support integrated ecosystem assessment in collaboration with research stakeholders and scientists. Mission |

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| Atlantic needs to know what the intended outcomes of such a workshop should be and hoping that WKEDU and Mission Atlantic can collaborate and even combine forces on this initiative.<br><br>How can Mission Atlantic support WKEDU? If anyone would like to join the workshop or suggest stakeholders, please get in touch with Mary Wisz or Mary Gassala. |

## 2.14 Arnault LeBris, Memorial University –Marine Institute

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| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2-3 years |
| **Approximately how many students graduate annually?** | 10 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | We do not have these information yet because our program is only three years old and we haven't had enough graduates yet. |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 4-5 years |
| **Approximately how many students graduate annually?** | 5 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | Data not available yet because our program is only 3 years old. |

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| • 50 years engagement with ocean industries – have a lot of funding<br>• Unique geographical location in the Northwest Atlantic, the gateway to the Arctic<br>• Tremendous opportunities for field experience at sea in graduate research projects as a result of involvement with research platforms, Arctic Ice breaker, DFO, RV<br>• Successful grantsmanships, which are currently major sources of funding, capacity to target international, federal, provincial and industry funding<br>• Looking at fisheries as a food chain from ecosystems to post-processing including harvesting, assessment, and management. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |

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| • Better integration / collaboration with organizations involved in advisory processes.<br>• Recruitment is an issue due to geographically isolated location, cold climate, limited interest in fisheries sciences, limited availability of students with quantitative skills<br>• Economic outlook in the province |
| **Please explain how your institution collaborates with other educational institutions:** |
| Exchange of students, research collaborations. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| We are committed to follow university wide and national recommendations on EDI. |
| **Other comments** |
| A few ides for advancing this initiative are to expand network of collaborative institutions through increasing exchanges of graduate students and internships, developing transdisciplinary programs in marine sciences, and adapting to the rapidly evolving job market (i.e. R&D and ocean technology start-ups). |

## 2.15 Coilin Minto, Galway-Mayo Institute of Technology (GMIT)

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| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2 years |
| **Approximately how many students graduate annually?** | GMIT: MSc in Applied Marine Conservation, MSc in Conservation Behaviour - 24 students 2020 (one year prgrammes) IMBRSea International 2020 Total 204 across 2 years, GMIT 20-60 per year |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 70% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 3-4 years |

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| **Approximately how many students graduate annually?** | 1-5 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 80-90% |

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Strong links with agencies that provide advice, co-supervision, applied training, research topics relevant to advisory process, capacity in training in quantitative methods, diverse areas of expertise (fish and fisheries, marine mammals, seabirds, conservation, environmental impacts/pollution, aquaculture) in terms of research, teaching and collegiality, co-location of PhD students and staff, encourage transnational researcher mobility and size allows for interaction among research themes. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| Absence of a formal structured PhD programme. Many students are tied to a 3 year PhD funding window where they don't get such a deep training/placement opportunities during their studies. Permanent appointment are typically teaching appointments. Difficult to scale the program due to limited number of supervisory capacity for students. |
| **Please explain how your institution collaborates with other educational institutions:** |
| Lots of engagement, a good example is the IMBRSea Masters programme: http://www.imbrsea.eu/ . For PhD, many project-specific collaborations, including research visits, co-supervision and joint awards. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| GMIT as an institute attracts a diversity of different learners and provides support, flexible learning models. Diverse backgrounds and community. EU MARES programme priority to non-EU applications. Exchange programmes. Good gender balance. Former and current fisher graduates. Part-time and workplace programmes facilitate professional community engagement. Undergoing ATHENA Swan bronze award application. |
| **Other comments** |
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## 2.16 Yong Chen, University of Maine

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| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2-3 years |
| **Approximately how many students graduate annually?** | 10 |

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| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | >50% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | 1 |
| **Approximately how long do students take to complete the programme?** | 4-6 years |
| **Approximately how many students graduate annually?** | 5 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | Most |

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| Strong faculty and interdisciplinary programs covering marine biology, oceanography, resource economics and marine policy. State university so required to provide scientific advice on fisheries and located in the most fishery dependent county in Maine. Many programs offer fisheries marine science graduate training opportunities and have research opportunities with NOAA Fisheries and State. Full scholarships and fellowships for all research-based graduate students. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| Need to provide students with an opportunity for hands on experience and more interactions with management agencies |
| **Please explain how your institution collaborates with other educational institutions:** |
| serving on students graduate advisory committees, joint application of research grants, and internships |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| Outreaching, hiring unrepresentative undergraduate students as research assistants |
| **Other comments** |
| ICES Student review provides training to students in reviewing stock assessments, which is presented to the ICES Advice Drafting Group. Very good feedback from students and good experience for their career. |

## 2.17 David Secor, University of Maryland Center for Environmental Science (UMCES)

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| **Does your institution offer a Master's programme in Marine Science which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 2.5 years |
| **Approximately how many students graduate annually?** | 20 |
| **Approximately what proportion of graduates are employed in a position where a primary role is to provide scientific advice to decision makers?** | 60% |
| **Does your institution offer a Ph.D. programme in Marine Science, which might prepare graduates to provide scientific advice regarding living marine resources and human impacts on marine ecosystems?** | Yes |
| **Approximately how long do students take to complete the programme?** | 4 years |
| **Approximately how many students graduate annually?** | 5 |
| **Approximately what proportion of graduates become employed in a position where a primary role is to provide scientific advice to decision makers?** | 30% |

**Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:**

- Strong quantitative and problem solving training.
- Professional coursework in ethics, environmental problem solving, science writing and communications. Professional development workshops.
- Fisheries science program.
- Faculty heavily engaged in advisory work to NOAA, Councils, ICES, IWC, ASMFC, ICCAT, and EPA.
- NOAA Internship Program (EPP - LMRCSC) and fast track to NOAA positions.
- Annual science conference to help with peer to peer membership

**Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)**

- No specific marine policy track.
- Nascent "Environment and Society" track.
- Curriculum gaps in UMCES, policy, economics, human dimension courses
- Small student body
- Curtailed diversity, inclusion and peer-to-peer mentorship
- Governance: Policy changes require agreement between inter-institutional parties and there is limited incentives for faculty and administrators to fully engage in inter-institutional programs

**Please explain how your institution collaborates with other educational institutions:**

UMCES and its graduate program are unique in being inter-institutional across the Maryland University System and state (12 institutions). UMCES is a home institution of the NOAA Educational Partnership Program: LMRCSC (US nationwide, 7 institutions) promoting training and recruitment of a diverse workforce within NOAA. UMCES is home institution for

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| Maryland Sea Grant and a member of NOAA Cooperative Institute of the North Atlantic (8 academic partners). UMCES is co-lead organization with WHOI in administer an NSF grant which makes ICES-related travel awards to early career scientists. |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| UMCES is a home institution of the NOAA Educational Partnership Program: LMRCSC (US nationwide, 7 institutions) promoting training and recruitment of a diverse workforce within NOAA. Women dominate graduate student ranks. The NOAA Sea Grant Knauss Program has been an effective means to entrain women and minority students into advisory positions. |
| **Other comments** |
| Opportunities (food for thought):<br>• Annual Science Conference as an entry into ICES work, travel awards to early career scientists<br>• Make ASC more student friendly – networking, international fora and follow ups<br>• ICES and offshore wind developments is a big opportunity for early career scientists training, focusing on multi-sector industries and novel monitoring assessment management interfaces<br>• Cooperative institutions for the North Atlantic region as an umbrella entity for graduate training to fill in coursework gaps, provide venue for team-training in fisheries advisement and access to NOAA scientists and managers |
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## 2.18 Mikko Heino, University of Bergen (UiB)

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| **Please briefly summarize the strengths of your (post) graduate programmes in preparing students for employment in advisory processes:** |
| UiB considers itself a blue university with marine research as a core area. Working with faculty from IMR and have applied dimensions of the MsC in fisheries biology and management. |
| **Please briefly summarize the limitations of your (post) graduate programmes in preparing students for employment in advisory processes (in other words, if you could make a handful of changes to reach this outcome, what would they be?)** |
| Historically had a lot of students from global south, but now have a lot of foreign students from Europe. The programme is limited because staff are not renewing themselves and repeating a lot of the same curricula. |
| **Please explain how your institution collaborates with other educational institutions:** |
| Institute of Marine Research, NORCE |
| **Please describe any efforts you are taking or plan to take to recruit women, indigenous people, underrepresented minorities and fishers into these types of (post) graduate programmes:** |
| |

# Annex 1: List of participants

| Member | Dept/Institute | E-mail |
|---|---|---|
| Alida Bundy | Fisheries and Oceans Canada Bedford Institute of Oceanography | alida.bundy@dfo-mpo.gc.ca |
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| Anya Waite | Ocean Frontier Institute Dalhousie University | anya.waite@dal.ca |
| Arnault LeBris | Memorial University of Newfoundland | Arnault.LeBris@mi.mun.ca |
| Cóilín Minto | Galway-Mayo Institute of Technology | Coilin.Minto@gmit.ie |
| David H. Secor | University of Maryland Center for Environmental Science | Secor@UMCES.edu |
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| Francis Neat | World Maritime University | fn@wmu.se |
| Gavin Fay | University of Massachusetts Dartmouth School for Marine Science and Technology | gfay@umassd.edu |
| Geir Huse | Institute of Marine Research | geir.huse@hi.no |
| Ian O'Connor | Galway-Mayo Institute of Technology | ian.oconnor@gmit.ie |
| Jan Jaap Poos | Wageningen University & Research Wageningen Marine Research | Janjaap.Poos@wur.nl |
| Janet Nye | Environmental Protection Agency Atlantic Ecology Division | janet.nye@stonybrook.edu |
| Jeremy Collie | University of Rhode Island Graduate School of Oceanography | jcollie@uri.edu |
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|---|---|---|
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| William Karp | International Council for the Exploration of the Sea | bkarp@uw.edu |
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| Yong Chen | University of Maine | ychen@maine.edu |

# Annex 2: Resolutions

It was proposed to revise the Terms of Reference and initiate a three-year working group.

WKEDU (Workshop on Graduate/Post Graduate Education Strategy to Meet Future ICES Advisory Needs) will meet remotely in November/December 2020 to address the following Terms of Reference:

1) Summarize expertise required to meet current advisory needs and identify likely future expertise requirements for providing advice that supports ecosystem-based decision-making for the management of human activities in marine ecosystems.
2) Evaluate opportunities and impediments related to building interdisciplinary, multi-institutional, international graduate/post graduate programs (while the primary focus is to address future ICES advisory needs, broader capacity building needs should also be taken into account) (Accreditation)
3) Review/summarize current single- and multi-institutional programs that support needs identified above and identify successful models
4) Identify issues that must be resolved to allow this initiative to move forward, describe next steps and a draft a roadmap for developing a curriculum within 3 years (Capture broad description of core competencies, balance between disciplinary expertise/broader multidisciplinary needs, better defined short-term goals – year-by-year basis (E.g. ICES stamped courses/share course curricula/exchange students/summer school, build on e.g. T curriculum framework/PG Cert; consider how to communicate guid-ance to students on professional skills needed/potential for employment/available funding )
5) Describe/propose a process for accomplishing these TORs, including possible formation of an expert group and further workshops
6) Evaluate and incorporate approaches for improving (post) graduate education opportunities for women, underrepresented minorities (consider recruitment strategies), indigenous people and fishers (e.g. DTU education in Greenland) through this initiative
   Consider short and long-term things – for women groups/special grants/better profile actively participate in existing networks. Recruit greater diversity/flexibility/Inclusion – peer-to-peer mentorship. Retention – career development personal capacity. Create spaces where people feel included/empowered – make opportunities that allow people to that. Need money to support participation. Start the conversation early and understand what would be the major obstacles for these issues. Consider adding some specific expertise/diversity(please consider suggesting specific names). Need a champion at the top.
   Consider partnerships in educating students (industry/NGOs) consult with students on their experiences.(Consider a specific group on diversity that ensures diversity is embedded throughout our work/network?)

# Annex 3: Notes from breakout groups

## Breakout group 1

Things to consider: professional skills, social science, ecological, transdisciplinary, sustainability, experimental design, quantitative skills, hands on, decision-making arena exposure, internships, innovative mindset.

Goal: Make graduates useful for an ICES working group. (MS level)

"Deliberately train people to be better at what they are in the knowledge co-production advice based arena"

From US National Academy of Sciences Recommendations for STEM:

1. Disciplinary and interdisciplinary knowledge: Master's students should develop core disciplinary knowledge and the ability to work between disciplines.

2. Professional competencies: Master's students should develop abilities defined by a given profession (e.g., licensing, other credentials).

3. Foundational and transferrable skills: Master's students should develop skills that transcend disciplines and are applicable in any context, such as communications, leadership, and working in teams. These dimensions are especially critical as the lines that traditionally define scientific and engineering disciplines become blurred—and more scientific research and application are characterized by the convergence of disciplines.

4. Research: Master's students should develop the ability to apply the scientific method, understand the application of statistical analysis, gain experience in conducting research and other field studies, learn about and understand the importance of research responsibility and integrity, and engage in work-based learning and research in a systematic manner.

From DTU general competences:

Knowledge and understanding: A graduate of the MSc Eng. programme from DTU

- has a solid understanding of and a firm base of knowledge in natural sciences and technological principles, possesses comprehensive knowledge within a given subject area, and is familiar with the current development trends and opportunities within the academic area
- can identify and reflect on technical scientific issues and understand the interaction between the various com-ponents of an issue
- can, based on a clear academic profile, apply elements of current research at international level to develop ideas and solve problems
- has insight into and understanding off the internal interaction between the various engineering domains and other competencies in connection with solving specific engineering problems
- possesses knowledge of sustainability, innovation and entrepreneurship

Skills: A graduate of the MSc Eng. programme from DTU

- masters technical scientific methodologies, theories and tools, and has the capacity to take a holistic view of and delimit a complex, open issue, put it into a broader academic and societal perspective and, on this basis, propose a variety of possible actions
- can, via analysis and modelling, develop relevant models, systems and processes for solving technological problems
- can communicate and mediate research-based knowledge both orally and in writing
- can discuss technological issues with various types of stakeholder
- is familiar with and can seek out leading international research within his/her specialist area

Competencies: A graduate of the MSc Eng. programme from DTU

- masters technical problem-solving at a high level through project work, and has the capacity to work with and manage all phases of a project – including preparation of timetables, design, solution and documentation
- can work independently and reflect on own learning, academic development and specialization
- can independently combine his/her technological knowledge with knowledge of business, management,

The MSc Eng. programme qualifies the graduate to hold positions in the private and public sectors, the consulting industry or to apply for research training with a view to earning a PhD.

From a recent Graduate education proposal:

- students encounter multiple viewpoints on the entire scientific enterprise – knowledge base, methods, and ways of learning - and be encouraged to critically evaluate evidence from this broad perspective
- students create their own project-based learning opportunities to develop and practice their transferable professional skills in a safe space
- students from all backgrounds, lived experience, and identities reach their fullest potential because the learning ecology provides an equitable and inclusive environment where different ways of generating knowledge are not only respected, they are sought out.

## Prerequisites (what we require from a qualifying Bsc program):

- Basic biology, economics, statistics, anthropology, geography or related disciplines
- Basic statistics
- Basic programming

## Competences (skills useful in an expert group for a quantitative Biol-ogy/Modelling type)

Can ...

- explain basic biological equations
- recognize if a model does not describe data well via standard diagnostics
- setup, configure, and derive output from one or more models in a competently
- write code to implement or modify assessment models in a meaningful way
- Work across disciplines (and stakeholder groups) for collaborative knowledge building (stakeholder engagement, facilitation)
- Apply systems thinking to marine problems - e.g. conceptual models for scenario creation

- Understand social/policy constraints associated with implementing the output from scientific advice
- Research computing skills - social coding, reproducibility in scientific workflow, open data science, etc. (value of this approach rather than say learning github, TAF, stock-assessment.org, etc.)

Other skills /knowledge/ competencies that probably won't be part of this program

### Courses

- ++Biological models (stock eq, catch eq, Von Bertalanffy, Ricker, Beverton-Holt, ...)
- ++Validation of assessment models (residuals, retro, leave-out, jitter, Piner, consistency... )
- Applied assessment and management (use pre-packaged assessment models to estimate historic time seri+es, produce model diagnostics, determine stock status and exploitation level, and provide catch advice ...)
- ++Non-standard model building (statistical models, parameter estimation, quantification of uncer-tainties, frequentist and Bayesian inference, model validation, count data, composition data, correlations, random effects, stochastic simulation, prediction, equilibrium, spatial models, TMB, ... )
- +++Research computing (shared code, scripting, reproducibility, parallel computing, data visualization, ... )
- +Living marine resource life history and ecology
- +Marine policy implementation & management (systems thinking to marine ecosystem-based advice, conceptual modelling, participatory model building, trade-off analyses, ecosystem services)
- ++++Project based internship course

### Curriculum?

We did not get this far, but plusses ("+") besides the courses outlined above indicates how many considered each course mandatory (base on 1 minute task of picking exactly 4 courses)

### Consideration of next steps

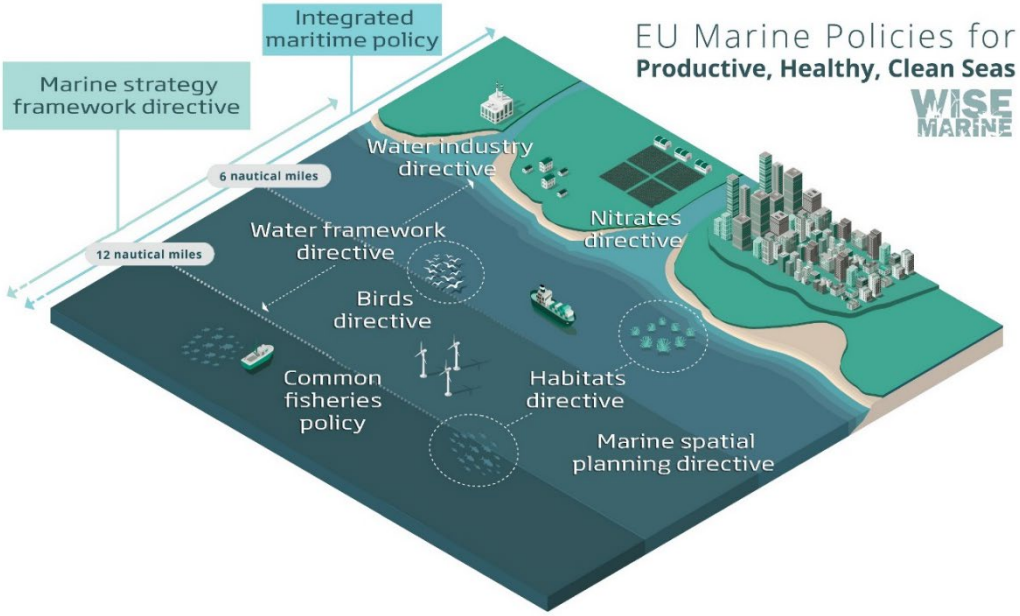
What goes into this program and what can people get afterwards?

## Breakout group 2

TASK: Address ToR #2:

Evaluate opportunities and impediments related to building interdisciplinary, multi-institutional, international graduate/post graduate programs (while the primary focus is to address future ICES advisory needs, broader capacity building needs should also be taken into account)

Given the breadth of ICES needs, one institution cannot do it all. Partition up some of the expectations – some institutes better fitted to some skills than others.




Needs:

1. Quantitative Stock Assessment and
2. Quantitative approaches more broadly
3. Social Science, Inter and transdisciplinary expertise
4. Engineering & ecology, to reduce bias (1 and 2 tend to focus on precision)

## Opportunities

**Build on existing models for building interdisciplinary, multi-institutional, international graduate/post graduate programs:**

- MASTS – Scotland Wide - see presentations
  - larger institutions tend to be less flexible, but where there is a will there is a way and widens the pool of potentially active achievers
  - Focus initially was on capacity building in research, recruited a lot of academics, set up research collaboration structure, consisting of three Themes and (now) 12 Research Forums, covering broad spectrum of marine science
  - Graduate school developed after first few years, set up to support PhD students.
  - SUPER (Scottish Universities Partnership for Environmental Research) funded by National Environment Research Council (UK research body) for 4 years (2019-2022) of fully funded (fees, stipend and research grant) 3.5 year PhD studentships. Approx 75 studentships available. NB HEI contribute proportion (33%) of funding.
  - Other funding available through industry government partnerships: 78 MASTS studentships in place to date.

- SUPER follows the "T-shaped" approach to professional development (Figure 2), combining dedication to an area of research supported by translational and life skills that provide a platform for future development and employment in re-search, government and industry. Breadth augmented by opportunity to ob-tain a postgraduate certificate (PG Cert) in Researcher Professional Develop-ment

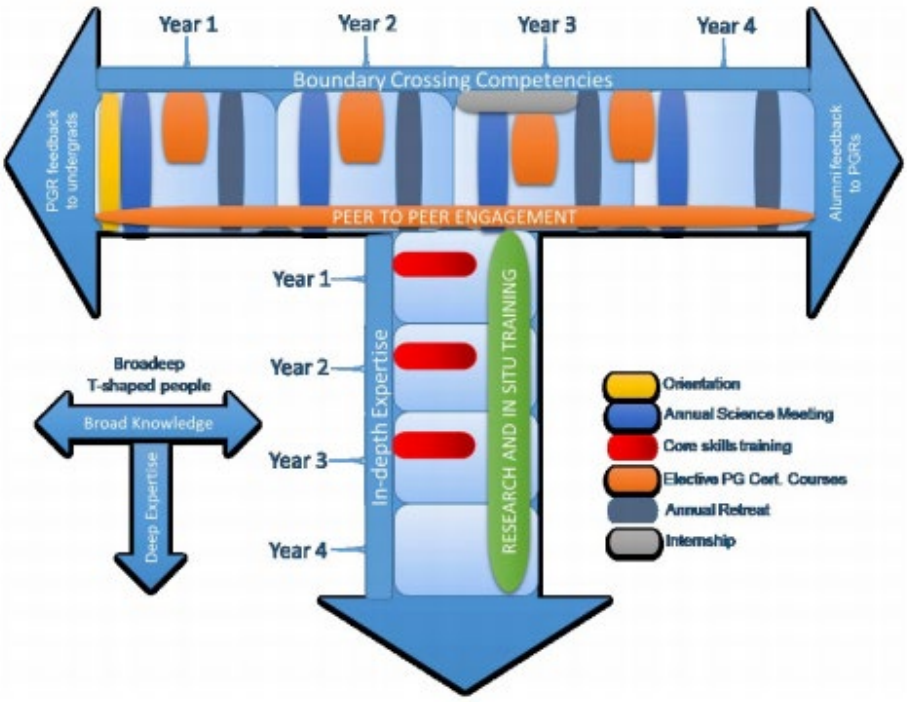



**Figure 1. The SUPER approach to "T-shaped" development of postgraduate training**

- Some collaboration with non-HEI partners for Masters project placements and ideas through Making the Most of Masters initiative.
- MASTS Annual Science Meeting is biggest marine science event in UK (507 registrations in 2020 from 28 countries, 85 talks in 14 sessions, 4 workshops).
- MSc and BSc training restricted to individual HEIs, with few instances of shared programmes.
-

– ERASMUS – EU Wide
  - Joint Master's program across ~ 11 universities (www.imbrsea.eu)
  - Vast differences in formative programs in terms of their undergrad programs. Re-imagined to concept of Master – is there a suite of programs that can be tai-lored for the end-users.
  - Take the best of all - don't need to create something new.
  - Curriculum is always dynamic, framework we created allows for partners to enter/leave, update/change modules
  - Framework allows them to give joint awards. EU credit system. Can reimagine something that combines the best of multiple award programs. Different ways of marking credits in different universities, but this was overcome
  - Joint PhD across ~13 universities. (www.mares-eu.org) 2010 – 2018 EM funded, that stream is now in MSCA EJD

- Greater differences for entry masters – meet exam IN BOTH organizations.
- 4-5 different streams
- 
- Add ICES stamp to PHD approval. Take programs that add to PhDs.

Ideas to for interdisciplinary, multi-institutional, international graduate/post graduate programs:

ICES Accreditation

- ICES could consider accrediting courses/programs at MSC and undergraduate levels in EU. This could make courses more attractive AND make them more tailored to ICES needs.
  - In the USA, the American Fisheries Society does something similar and has a a fisheries program for undergraduates with requirements for major/minors.
  - See also IMAREST accreditation

ICES Scholarship

- Could tie this be funded by e.g. Marie Curie Program – e.g. this group would put together a proposal for 5 years of training (this could also be coordinated with US/CAN but they would need to supply their own funds)
- Marie Curie co-fund with ICES sharing – Could do multiple intakes.

ICES Modules and Internships

- Engagement of ICES more directly with universities and students
  - Engage students with real problem solving by linking ICES needs and questions to universities needs for problem activities, ie provide students with direct opportunities to experience ICES work.
  - E.g. [Formally] distribute benchmark worklist to partner HEIs [although nothing to stop participants distributing as is, but just hard to find e.g. online].
  - Students would be supervised by university profs, but their research projects would directly relate to ICES needs. Exposes students to scientists. Idea is not to burden ICES or local institutes.
  - This would introduce a large pool of people to ICES.
  - Could also increase understanding of ICES needs and operation
  - Could also couple this with placements in National Government Labs, but again to avoid burden on staff, it is better to have supervision by University.
  - 
- In the USA, they have something like this at the doctoral level – Fellowships joint funded by NOAA Fisheries and National Sea Grant Program , supporting PhD students studying population and ecosystem dynamics and resource economics. This is a national competition open to all universities in US for 3 years funding. Sea Grant fund needs to have 50% match from state agencies or universities. The project proposals are student driven. NOAA has a selection committee, and between 5-10 per year students are selected each year.
- ICES student led stock assessment review: In the USA, ICES provides short term student exposure to scientific process. A group of students in a quantitative program are

given a group of ICES stocks to review. Students don't need to travel. Prepare report, review groups, and advising group. Students Present back to ICES Advising Group. Involve 20-25 students. Hands on experience. There is a one week turn around, so students spend whole week doing this. How deep do they go into the review? Read all the background information. They had also rejected reports if not deemed properly. The rejected stock assessment report would not be used for catch advising. Don't rerun the assessment though.

- Could this be rolled out for EU students too? Or is there insufficient independence? Could EU students review US stocks through the Center for Independent Experts (Or Canadian?) through a similar process?

ICES Scientist serves on student committees?

ICES Program:

- Be ambitious and conceive of what a program would look like.
- Focus on the demand side then focus on what institutions can deliver the skills,
- Design new skills from bottom up? Some will already exist.
- Build up over time over and extend?
- Design learning outcomes for the program then look at who can do it?
- Long process to get institutional agreement for a joint award
- Could have a taught program at MSc level and a 1 yr intership/placement with a defined outcome in an ICES area of interest. High value for students.

**Social Science, Inter and Transdisciplinary Education – what social sciences do we need to consider?**

- Anthropology, sociology, economics, geography, history, psychology, international law, environmental law, etc…… do we need to state what these are – ie what does ICES need?
- There are all large disciplinary areas – the extent to which theses disciplines are focused on fisheries and ocean management in any universities that might be part of a collaboration to be determined.
    - Universities proximate to the ocean/aquatic resources likely to have more ex-pertise in this area (e.g. Memorial University, Canada; VIMS)
- ERASMUS as an example of an interdisciplinary program –No single Masters program can address needs of broad interdisciplinary needs. Students pick from a range of options to meet their credits. They decide from the outside where they want to focus.. Needs partnerships. Main biology focus, but that also covers a large area.
- What can we learn from those involved in ICES WG e.g., WG SOCIAL, ECON, the IEA WGs, SIHD, etc…. ?

## Impediments

Marketisation of education and competition for students can lead to tensions and inhibit cooperation

Differences between and within N American and European education systems. UK - 1 yr course based; US/CAN – 2 years, take courses while doing research; Europe largely 2 yr MSc.

- Incoming students with different levels of experiences
- Degrees of MSc? How to tell them apart?
- MSc students from 1yr MSc that is not recognized elsewhere in EU e.g. Spain

Tuition Fee Disbursement – but this can be surmounted

- How do you resolve tuition issues when across institutions?
- MAST – PhD tuition fees are split between supervisor institutions
- ERASMUS+– equivalence – so cost neutral, students in existing programs can undergo mobility for credits or internships
- IAN – recruit ~ 100 students per year = money from somewhere – money goes to institutes for length of time student spends. 80% are fee paying, some scholarships

Fisheries and Oceans Management cannot (yet) compete with charismatic megafauna and corals

- How to attract more students into quantitative, applied fields? Or policy?
- Not so much an issue with research grad schools in US. Availability of funding in US. Paid by advisors
- In UK, students pay for MSc – in EU also and some are funded by countries (marketisation)
- ICES should reinvest and earn while you learn – need to come from where the resources are

## Considerations

MSc vs. PhD level – what is ICES looking for? BSc? All relevant.

Different job markets for Msc and PhD, many more Masters than PhD.

Is there a sense of scale of what is needed on the demand side? Ie by ICES

Breadth vs. depth –(see e.g. Figure 1) broad undergrad in US, slightly less in EU, narrows as people move through. Is depth being diluted through broader needs? We don't want this:


**Figure: drawn by Bas Kohler …from Thebaud et al ICES Journal of Marine Science (2017), icesjms/fsw252**

## Breakout group 3

Sketch out a **draft curriculum** for the program (not too prescriptive, thought experiment)

- Core requirements (Modular structure)
  - *Ecological Detective* (Hilborn and Mangel Book)
  - Fisheries Ecology (Jennings and Kaiser Book, augmented with newer material, e.g. evolutionary effects of fishing, length-structured models (Ken Haste Andersen)
  - Nuts and Bolts of Fisheries Science (Population Dynamics, Stock Assessment, …)
  - Fisheries Economics (e.g. Clarke or Andersen and Secor)
  - Behavioural Economics (book?)
  - Aquaculture and the role thereof in the production of animal protein
  - Food and nutrition from the Ocean
  - Cross-faculty modules (including e.g. Students from Nutritional Science, Biology and Law of the Sea)
  - Teaching through projects (e.g. have groups of students develop a small project, e.g. on interviewing ocean actors)
  - Biological Oceanography
  - Trade-offs in conservation and use of marine ecosystems

- Electives/areas of specialization
  - Ethics
  - Law
  - Policy
  - Moderation and facilitation, conflict resolution, reasoning, diplomacy
  - Management Strategy Evaluation (broader than fisheries)
  - Risk Assessments
  - Environmental Impact Assessment
  - Course on intercultural competence

**Hands-on experience**

- Role-Playing games (e.g. playing through the development of a management plan with roles as fisher, scientist, policy-maker, NGO representatives, journalists) learning negotiation and finding compromise; safe environment to test, no too intimidating;
- Being cognisant of culture differences in negotiating, communicating, others
- National Lab placement
- Strengthening partnerships between Universities and ICES
- Sending students to assessment group meetings and advice drafting groups
- Opportunities for Universities to exchange students among each other
- Looking at Erasmus+ transnational joint master programmes

**Diversity**

- Mentoring Programmes for specific groups
- Highlighting structural challenges in the university systems
- Funding is based on gender equality (e.g. Athena SWAN Charter, https://hea.ie/policy/gender/athena-swan/)
- More challenges in terms of other diversities (e.g. cultural, ethnic diversity); partly an outreach problem, to a large extend also structural?
- More voices needed at the table for this issue; be more conscious when organizing future workshops

**Additional**

If time allows, thoughts on next steps for this initiative would be very welcome, including:

- Changes/additions to the terms of reference
- Tasks that might be worked on before our next meeting
- Thoughts for how best to configure a future workshop/working group meeting.

Notes:

- Maintain communication, use the workshop participants as ambassadors to communicate back into the institutions
- Matching the advisory needs of ICES with the national lab expertise needs or vice versa (the educated people need to find a job somewhere…)
- Graduate Programmes need to match employment opportunities

Mary: Freshwater fisheries science important

Academic career

## Breakout group 4

Main Points:

Recruit from a wide range of backgrounds (by opposition to mostly biology/ecology/environmental sciences undergraduates)

Length of the program around 1 year including:

- initial training on core disciplines (i.e., Fisheries Science, Ocean Studies, Social Sciences, Economics, Policy and Governance. Possibility of adding specific training if needed (i.e., statistics).
- Problem based training in small groups in issues relevant for ICES needs.
- Consider career development issues concerning equality of opportunities (with respect to gender, ethnicity, and culture)

Should include PhD and MSc students

The training can be integrated into already existing formal academic programs.

Other issues discussed:

Consider mechanisms to include trainees from countries that are not ICES members?

Consider part of the program online?