Theme session I 2021

Session I - The impacts of marine shipping and their effects on coastal communities and ecosystems

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Session Synopsis

The distribution and intensity of commercial shipping is increasing, and there is a growing need to assess—and mitigate—the impacts of vessel activities on the marine environment. Vessel activities can have transboundary impacts, and successful mitigation efforts require coordination and collaboration between trade partners. This theme session focused on the impacts of shipping-related stressors and applications of cumulative effects assessment to balance the benefits and costs of this industry.

A total of 17 submissions was received, and they were well-suited for the session. Indeed, all abstracts were accepted, either as talks (14) or posters (3). They naturally fell into four broad categories:

- Physical Pressures
- Chemical Pressures
- Biological Pressures
- Synthesis of pressures

In this manner, the session was organized around four panels with these topics.

The contributions of Early Career Scientists were highlighted. That is, each panel began with a brief (2-3 minute) re-capitulation of an Early Career Scientist's talk or poster. Next, questions were posed to a panel made up of the Early Career Scientist plus three additional delegates whose talks were relevant to the topic.

The session was well attended: 144 people either viewed the pre-recorded presentations or participated during the live session. Throughout the session, two poll questions posed to delegates were briefly discussed. The outcomes of the panel discussions and group's responses to the poll questions are described below.

Panel: Physical Pressures

The opening talk, "Short and long-term effects of low-sulphur fuels on marine zooplankton communities" (by Christina Jönander), was one of two presentations in the session to investigate the toxicity of hybrid fuels relative to marine gas oil. The discussion highlighted another theme of the talks: additive or synergistic effects of

multiple stressors. In this case, it was agreed that other emissions high in organic chemicals likely interact with hybrid fuels to harm aquatic organisms.

Underwater noise was discussed as well. While it was unclear if there is evidence of long-term adaptation of these organisms in noisier environments, it is true that population differences among marine mammals have been observed, and noise is a growing problem. From a policy point of view, there is a lack of data, stemming from the difficulty in counting and tracking affected marine organisms (e.g., fishes and mammals). This represents a data gap. In considering the effect of ships' turbulent wakes on noise, it was assumed that the bubbles evolved from ships and propellers could affect the underwater noise field.

Panel: Chemical Pressures

This panel began with a presentation on "Assessing shipping-related oil spill risks in the Arctic: From accident probabilities to ecological consequences" (by Inari Helle). Both chemical and physical properties of the oil were inherently considered, as mortality (from any cause) of marine mammals was the endpoint for this probabilistic oil spill risk assessment for Arctic marine areas.

Again, a lack of data was discussed. Because oil spills are (thankfully) rare, few real-world data are available. It was agreed that additional, existing datasets (e.g., from the Baltic Sea) may be useful in further informing the model. In this regard, models used by the oil industry may be useful; however, they tend to focus on points rather than long tracks, so their utility may be limited for this application.

Whether the toxic effects of hybrid fuels would interact with the pollutants from other ship operational discharges was discussed. In shipping lanes, the effluents will mix, possibly acting as additive or synergistic multiple stressors. Climate change is expected to exacerbate the issue of toxic fuels, but at this point, it is unknown if the effects would be additive or synergistic.

Panel: Biological Pressures

The panel's focus was on biofouling, starting with the presentation "Developing a decision support model for optimizing biofouling management in the Baltic Sea" (by Emilia Luoma). From the model, the optimum way to control biofouling is using a non-biocidal coating and in-water cleaning with filtration to capture particles in the effluent. However, this approach is not used by all ships, as the best coating type is a function of the ship's operational profile. There was an active discussion on the implications of these findings with questions from multiple participants.

The cleaning frequency of a ship's coating varies by coating type, season, and trading route. In general, in-water cleaning occurs twice per year for ships with biocidal coatings, but for ships with non-biocidal coatings, cleanings occur once or twice per month throughout the growing season. Typically, cruise ships have hard, non-biocidal

coatings, and their frequent port calls allow for cleaning more easily than for other types of commercial ships. Regarding routes, in the Baltic Sea, the northern, lower-salinity area tends to have less fouling than the southern, higher-salinity area. Thus, the frequency of in-water cleaning will differ within the region.

It was noted that in-water cleaning may need to be incorporated into a ship's biofouling management plan so that the coating is thick enough to be maintained over multiple cleanings. This will also depend on whether a ship plans to have a regular cleaning schedule or if it initiates cleaning based on fuel consumption (when fuel consumption increases due to increased drag from biofouling, cleaning occurs).

Finally, the evolution of fine coating particles during in-water cleaning was considered. Because holes in filtering devices vary, and exceptionally fine particles will inevitably bypass the devices, particles can be released. This is an issue of concern. At a coarser level, filtration increases the cost of the procedure and is not required in every port, so many shipping companies do not opt to use a filtration step.

Panel: Synthesis of Pressures

The final panel began with the presentation "Fouling prevention vs copper pollution" (by Maria Lagerström). In this study on leisure boats, all coatings performed similarly. In other instances, though, when different coatings perform differently, there will be trade-offs. This will require a thoughtful use of biocidal coatings: if fouling is not well controlled, more fuel will be needed to move ships through water, resulting in greater air emissions.

In this panel, two models to assess the impacts of shipping were discussed, an economic model and a conceptual model. It was agreed that it might be possible and beneficial to combine the economic model with the Driver-Pressure-State-Impact-Response (DPSIR; conceptual) model. Regarding the conceptual model, it was suggested that the drivers could be subdivided into the activities that relate to the distinct types of vessels, for example, transport of goods, transport of people, leisure activities, safety measures, etc. [Although it seems they are inherently included already; for example, cruise vessels generate enormous volumes of grey water compared to tankers, and the different ship types' operational differences will already be included when summarizing the grey water volumes (in this example).]

Using the economic model, it would be possible to break out the costs by pressure or sub-system to see which mitigation actions save the most money. For example, early results of the model indicate that the highest costs to the marine environment—eutrophication by nitrogen—are largely due to nitrogen oxides (NOx). Hence, establishing a NECA (NOx Emission Control Area) in the Baltic Sea is an important measure. Additionally, toxins from biocidal (copper) coatings have a high damage cost.

Poll Questions

The first question was posed in advance of the session:

> "If you are actively engaged in commercial shipping research, please type your area of research (e.g. scrubber water, cumulative effects, biofouling, policy, oil spill)."

From the 19 responses, most delegates were engaged in ballast water or antifouling research (Figure 1). This was followed by cumulative effects and aquatic ecotoxicology. Fewer delegates listed engagement in oil spill, noise, or microplastic research. One respondent was from outside the field ("not engaged").

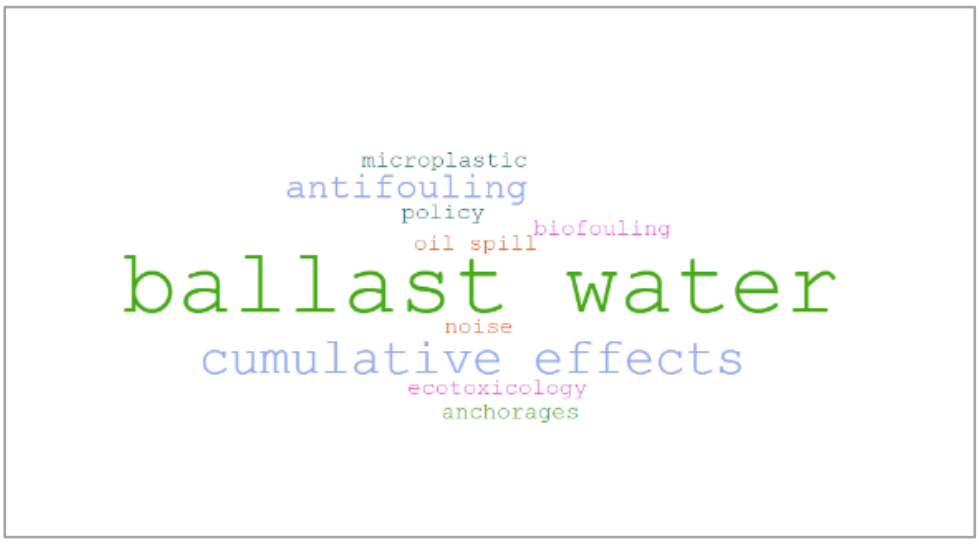

Figure 1. *Delegates' research areas (from the answer to Poll Question 1).*

The second poll question asked the delegates about environmental risks:

> "Which shipping pressure poses the highest risk to the marine environment?"

The 16 responses were more varied than the first question (Figure 2). Airborne/carbon emissions, invasive species, and species introductions were the most frequent answers.

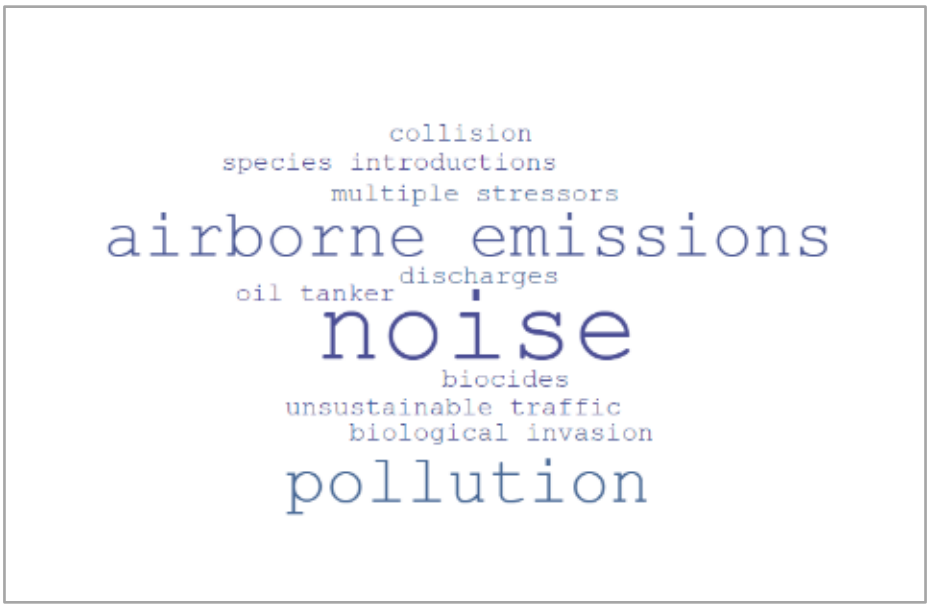

Figure 2. *Delegates' research areas (from the answer to Poll Question 2).*

Conclusions

In sum, the session was a useful opportunity to bring together multidisciplinary experts who may not typically exchange ideas. Given the lack of available data to address the complex issue of ships' environmental impacts, there is a clear need to join existing data sets and models that are currently used. These joint efforts would help elucidate the effect of single stressors (oil spills or underwater noise) as well as multiple stressors (via the economic or conceptual models of ship impacts). From the poll question, there was no consensus on which stressor is most important. This suggests that the handful of major stressors should continue to be investigated, with the aim to quantify their effects, both singly and in combination.