

Supplementary material

Biosecurity risk associated with bilge water from small vessels: an evaluation of systems and operator behaviours

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Table S1. Descriptive information regarding individual vessel characteristics, bilge water and the vessel, and opinion regarding the viability of bilge water as a mechanism for the spread of marine pests for commercial vessels grouped by activity type

Figures show percentages of respondents within each activity type. NA, not applicable

Vessel characteristics		Charter services (n = 4)	Dive support (n = 3)	Fishing or aquaculture (n = 2)	Harbour patrol (n = 5)	Marine construction (n = 1)	Research or consulting (n = 2)	Shipping support (n = 3)
Number of pumps	0	25	0	0	0	0	50	0
	1	50	33.3	0	0	0	0	33.3
	2	0	66.7	0	80	0	50	66.7
	3	0	0	50	0	0	0	0
	4	0	0	0	0	0	0	0
	5	0	0	50	0	0	0	0
	6	0	0	0	20	100	0	0
Pre-discharge treatments	Unknown	25	0	0	0	0	0	0
	In-line filters	0	0	50	0	0	0	0
	Pads or sponges	25	0	50	0	0	0	0
	None	50	100	0	100	100	100	100
	Unknown	0	0	0	0	0	0	0
Bilge system operation	NA	25	0	0	0	0	0	0
	Automated	0	33.3	0	0	0	0	0
	Manual	25	33.3	0	0	0	100	100
	Both	50	33.3	100	100	100	0	0
	NA	25	0	0	0	0	0	0

Vessel characteristics		Charter services (n = 4)	Dive support (n = 3)	Fishing or aquaculture (n = 2)	Harbour patrol (n = 5)	Marine construction (n = 1)	Research or consulting (n = 2)	Shipping support (n = 3)
Use of operation	After vessel on plane	0	0	0	0	0	50	0
	After activities	0	66.7	0	0	0	100	0
	After rough seas	0	33.3	0	0	0	50	0
	After wash down	0	33.3	0	80	0	100	0
	Other	0	0	50	0	0	0	0
	None	75	33.3	50	20	100	0	100
	NA	25	0	0	0	0	0	0
Sources of water	Waves or sea spray	0	33.3	0	60	100	100	0
	Via propeller shaft seal	25	0	0	0	100	0	0
	Engine cooling	75	0	0	0	0	0	0
	With recreational equip.	0	0	0	0	0	0	0
	With commercial equip.	0	100	50	40	100	100	0
	Wash down	0	66.7	50	40	100	100	0
	Freshwater	75	33.3	100	80	0	50	66.7
	Minor leaks in hull	0	0	0	0	0	0	0
	Other	0	66.7	0	0	100	0	66.7
	None	25	0	0	20	0	0	33.3
Where water accumulates	Bilge wells	75	33.3	50	60	100	0	66.7
	Bilge sump	0	66.7	50	60	0	100	0
	Anchor wells	0	0	0	0	100	0	66.7
	Uncontained water	0	0	50	20	0	50	0
	Live bait wells	0	0	0	0	0	0	0
	With recreational equip.	0	0	0	0	0	0	0
	With commercial equip.	0	100	0	0	100	100	0
	Other	0	0	0	0	100	0	0
	No water comes on board	25	0	0	0	0	0	33.3
Carries out maintenance	Yes	50	100	50	100	100	100	66.7
	No	50	0	50	0	0	0	33.3
Consider water risky	Yes	25	66.7	0	40	100	100	100
	No	75	33.3	100	60	0	0	0

Fig. S1. Boater questionnaire used to elicit information regarding the factors driving bilge water generation, including the influence of activities on board.

Part A. Vessel characteristics

1. What type of vessel do you operate?	
<input type="checkbox"/> recreational yacht <input type="checkbox"/> recreational motorboat <input type="checkbox"/> commercial vessel (e.g. fishing vessel, aquaculture, water taxi), please specify: _____ <input type="checkbox"/> other, please specify type: _____	
2. What is the length of the vessel?	
_____ metres or _____ feet	
3. What is the average cruising speed of the vessel?	
_____ knots	
4. Where is the vessel stored?	
<input type="checkbox"/> stored in water, what is your home marina or port? _____ <input type="checkbox"/> stored on land, what boat ramp do you most commonly use? _____	
5. How often is the vessel used?	
<input type="checkbox"/> daily <input type="checkbox"/> 2–3 times per week <input type="checkbox"/> at least once per week	<input type="checkbox"/> at least every month <input type="checkbox"/> at least every 3 months <input type="checkbox"/> once or twice per year
6. What types of trips did you take on the vessel in the last 12 months? Please tick all that apply.	
<input type="checkbox"/> day trips within the same region <input type="checkbox"/> multi-day trips within the same region	<input type="checkbox"/> multi-day trips to another region or regions <input type="checkbox"/> multi-day trips to another country
7. What is the vessel predominantly used for? Please tick the main activity carried out on board.	
<input type="checkbox"/> recreational activities e.g. fishing, diving <input type="checkbox"/> travel between regions e.g. cruising	<input type="checkbox"/> commercial activity, please specify: _____ <input type="checkbox"/> other, please specify: _____

Part B. Bilge water and your vessel

8. Is there a bilge pump on the vessel? If so, please specify how many pumps and the capacity if known.	
<input type="checkbox"/> no bilge pump on the vessel <input type="checkbox"/> bilge pump on the vessel – how many pumps? _____ gallons per hour rating? _____ GPH	
9. How is the bilge pump on the vessel operated?	
<input type="checkbox"/> manual operation only (i.e. the operator must <u>choose</u> to use the bilge system) <input type="checkbox"/> automated operation only (i.e. triggered by a float switch or operated on a timer) <input type="checkbox"/> both manual and automated operation are possible	
10. Does the bilge system have any pre-discharge treatments? i.e. to prevent release of contaminants such as oils.	
<input type="checkbox"/> in-line filters <input type="checkbox"/> oily water separator <input type="checkbox"/> oil-absorbent pads or sponges	<input type="checkbox"/> other, please specify _____ <input type="checkbox"/> no known pre-discharge treatments <input type="checkbox"/> don't know
11. Do you routinely conduct maintenance (i.e. draining and cleaning) of the bilge spaces within the vessel?	
<input type="checkbox"/> yes, how frequently? _____ times per year <input type="checkbox"/> no	
12. What are the areas of the vessel where water accumulates (i.e. bilge spaces)? Tick all that apply.	
<input type="checkbox"/> bilge wells <input type="checkbox"/> bilge sump <input type="checkbox"/> anchor wells <input type="checkbox"/> uncontained water on the deck area	<input type="checkbox"/> live bait wells or flow-through seawater tanks <input type="checkbox"/> associated with sports equipment e.g. dive gear <input type="checkbox"/> associated with commercial equipment e.g. nets <input type="checkbox"/> other, please specify: _____

13. What are the sources of any water entering the bilge spaces? Please tick all that apply and rate the significance of this water source (significant, standard or minor).

- _____ waves or sea spray breaking over the deck
_____ via the propeller shaft seal
_____ engine cooling
_____ bringing recreational equipment on board e.g. dive gear, fishing gear
_____ bringing commercial equipment on board e.g. scientific instruments, fishing nets, dredges
_____ seawater brought on board to wash down deck spaces or equipment
_____ freshwater sources e.g. rainwater, greywater, condensation
_____ minor leaks in the hull
_____ other, please specify: _____

14. What proportion of water coming on board the vessel would be from within a marina or port environment?

_____ % (please estimate to your best ability)

15. What is the maximum volume of water that can accumulate before the pump is activated (auto or manual)?

_____ litres (please estimate to your best ability)

16. What volume of water remains in the bilge spaces following operation of the bilge pump?

- 0–249 mL (i.e. less than 1 cup) 1 L–10 L (i.e. between 1 L and a bucket)
 250 mL–1 L (i.e. between 1 cup and 1 L) more than 10 L (i.e. more than a bucket)

17. Thinking about “average bilge operation”, how often does the bilge pump operate during a standard trip under the following scenarios? Please circle the option that best applies and indicate your usual standard trip length.

a. when steaming/cruising in ***fine/calm*** sea conditions, the bilge pump operates:

0 1 2 3 4+ times per _____ hour(s) of operation

b. when steaming/cruising in ***stormy/rough*** sea conditions, the bilge pump operates:

0 1 2 3 4+ times per _____ hour(s) of operation

c. when carrying out activities (recreational or commercial) in ***fine/calm*** sea conditions, the bilge pump operates:

0 1 2 3 4+ times per _____ hour(s) of operation

d. when carrying out activities (recreational or commercial) in ***stormy/rough*** sea conditions, the bilge pump operates:

0 1 2 3 4+ times per _____ hour(s) of operation

18. Are there any circumstances where you would routinely activate vessel's bilge pump?

- getting vessel up on the plane after washing down the deck
 after activities on board e.g. diving, fishing manual discharges are not possible on the vessel
 after periods of rough sea conditions other, please specify: _____

19. Do you generally set out on your trip with an empty bilge? i.e. you discharge any bilge water before departure.

- always (i.e. 100% of departures) sometimes (i.e. 1–49% of departures)
 most of the time (i.e. 50–99% of departures) never (i.e. 0% of departures)

20. Do you generally turn on the bilge system when arriving at your destination (in-water only, not once on land)?

- always (i.e. 100% of arrivals) sometimes (i.e. 1–49% of arrivals)
 most of the time (i.e. 50–99% of arrivals) never (i.e. 0% of arrivals)

21. Do you consider bilge water a likely mechanism for the spread of marine pests?

- yes
 no, please elaborate why: _____

Participant information: please provide your name and contact email if you would like to enter the prize draw.

Name:

Vessel name:

Email: