

Supplementary Materials

1. Supplementary Tables S1-S7

2. Supplementary Appendices S1-S5

Supplementary Table S1. Sampling sectors of hull-fouling macroinvertebrates on the research vessels.

Hull sectors	Sampling parts of the ship's surface
Upper	Just around waterline (ship's central and prow parts)
Middle	Mid depth (between the waterline and flat bottom)
Bottom	Flat bottom (ship's bottom including the seawater inlet part)
Niche areas	Propeller and shaft, thruster

Supplementary Table S2. Information on the research vessels such as the navigation area, tonnage, dimension, and sampling date based on KIOST operating guidelines.

Navigation area	Name of R/Vs	Tonnage (ton)	Length (m)	Speed (kn)	Cleaning date	Sampling date	Sampling dock
Ocean	ISABU	5,894	99.8	12–15	12 th –13 th Jan. 2017	12 th –13 th Jan. 2018	ORIENT shipyard
	ONNURI	1,370	63.8	12.5	28 th –29 th Mar. 2016	28 th –29 th Mar. 2017	ORIENT shipyard
Coastal	EARDO	357	49.0	12.0	15 th Mar. 2016	15 th Mar. 2017	SUNJIN shipbuilding
Coastal & Local	JANGMOK 2	35	24.0	16.0	15 th Mar. 2016	15 th Mar. 2017	SUNJIN shipbuilding
Local	JANGMOK 1	41	24.2	13.0	19 th Sep. 2016	19 th Sep. 2017	SUNJIN shipbuilding

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Supplementary Table S3. Operational records of the research vessels for one year from 2016 to 2017 (Abbreviations: Sail, sailing days; Anchor, anchoring days).

Research vessel	Operating region	Sail/Anchor by region	Month (Sail, Anchor)		Operating route	Anchorage harbor
ISABU	Ocean	186/22	Jan (5, 26) Feb (27, 1) Mar (13, 18) Apr (0, 30) May (13, 18)	Sep (26, 4) Oct (16, 15) Nov (28, 2) Dec (11, 20)	Indian Ocean, Northwest Pacific Ocean	Guam and Palau port, Colombo, Port Louis
	South Sea	25/124	Jun (20, 10) Jul (30, 1) Aug (30, 1)		South coast of Korea	Jangmok, Gwangyang and Busan port
	East Sea	8/0			Dokdo Is.	-
	West Sea	0/0			-	-
ONNURI	Ocean	101/9	Jan (0, 31) Feb (7, 21) Mar (11, 20) Apr (18, 12) May (17, 14) Jun (8, 22) Jul (29, 2) Aug (29, 2)	Sep (19, 11) Oct (21, 10) Nov (5, 25) Dec (1, 30)	Indian Ocean, Northwest Pacific Ocean	Colombo, Port Louis and Guam port
	South Sea	44/189			South coast of Korea, Korea strait, East China Sea	Siljeon, Seogwipo, Jeju, Mokpo, Jangmok, Busan and Jangcheon port
	East Sea	14/1			Ulleung Is., Dokdo Is.	Sadong and Pohang port
	West Sea	6/1			Yellow sea	-
EARDO	South Sea	77/151	Jan (0, 31) Feb (21, 7) Mar (16, 15) Apr (16, 14) May (22, 9) Jun (10, 20) Jul (15, 16) Aug (19, 12)	Sep (27, 3) Oct (11, 20) Nov (13, 17) Dec (10, 21)	South coast of Korea, East China Sea, Heuksan Is. Jeju Is.	Jangmok, Seogwipo, Jangcheon, Busan, Gangjeong, Wando, Jeju, Gamcheon, Jinhae, Gwangyang, Yeosu and Jangseungpo port
	East Sea	91/33			Ulleung Is., Dokdo Is., Yeongil Bay	Sadong, Pohang, Mukho, Sokcho, Ulsan and Imwon port
	West Sea	12/1			Yellow Sea	Gunsan port
JANGMOK 1	South Sea	102/186	Jan (0, 31) Feb (8, 20) Mar (7, 24) Apr (27, 3) May (15, 16) Jun (26, 4) Jul (15, 16) Aug (17, 14)	Sep (2, 28) Oct (15, 16) Nov (8, 22) Dec (1, 30)	South coast of Korea, Korea strait, Jeju Is.	Jangmok, Jangseungpo, Wando, Gangjeong, Swimi, Yeosu, Busan, Mokpo, Bigeumdo, Gukdong and Yokjido port
	East Sea	39/38			Jumunjin and Ulsan coast	Pohang, Mukho, Ulsan, Onsan, Imwon, Jukbyeon port
	West Sea	0/0			-	-
JANGMOK 2	South Sea	54/78	Jan (0, 31) Feb (11, 17) Mar (11, 20) Apr (2, 28) May (4, 27) Jun (29, 1) Jul (5, 26) Aug (3, 28)	Sep (28, 2) Oct (31, 0) Nov (14, 16) Dec (0, 31)	South coast of Korea	Busan, Jangseungpo, Wando, Jinhae, Jangmok, Jangseungpo and Tongyeong port
	East Sea	43/115			East coast of Korea, Ulleung Is., Dokdo Is.	Pohang, Sokcho, Jumunjin, Jukbyeon, Hyeongpo and Mukho port
	West Sea	41/34			Gocheong Is., Baengnyeong Is., Daechong Is.	Gocheongdo and Baengnyeongdo port

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Supplementary Table S4. List of native and NIS found among 47 species of hull-fouling macroinvertebrates in this study. The numbers are the sum of the number of individuals of macroinvertebrate species attached to the hull of each vessel. Asterisks indicate six native and eight NIS. Others are species of unknown origin.

No.	Phylum	Sub taxa	Abbre.	Species	Isabu	Onnuri	Eardo	Jangmok 1	Jangmok 2	Native	NIS
1	Bryozoa	Bugulidae	Bry	<i>Bugulina californica</i>				1	9		★
2	Bryozoa	Bugulidae	Bry	<i>Bugula neritina</i>					1		★
3	Cnidaria	Actiniaria	CAC	<i>Heteranthus</i> sp.			1				
4	Cnidaria	Hydrozoa	CHy	<i>Sertulariidae</i> unid.					3		
5	Mollusca	Gastropoda	MGa	<i>Cheilea cepacea</i>			1				
6	Mollusca	Bivalvia	MBi	<i>Hiatella arctica</i>		2	1				
7	Mollusca	Bivalvia	MBi	<i>Magallana gigas</i>		3	392	49	251	★	
8	Mollusca	Bivalvia	MBi	<i>Modiolus kurilensis</i>			1				
9	Mollusca	Bivalvia	MBi	<i>Musculus senhousia</i>			3				
10	Mollusca	Bivalvia	MBi	<i>Mytilus galloprovincialis</i>		8	126		88		★
11	Annelida	Polychaeta	APol	<i>Eteone longa</i>			1				
12	Annelida	Polychaeta	APol	<i>Hydroides ezoensis</i>		8	70		544	★	
13	Annelida	Polychaeta	APol	<i>Marphysa sanguinea</i>				1			
14	Annelida	Polychaeta	APol	<i>Nereis multignatha</i>			9	15	7		
15	Annelida	Polychaeta	APol	<i>Nereis pelagica</i>					2		
16	Annelida	Polychaeta	APol	<i>Perinereis nuntia</i>				1			★
17	Annelida	Polychaeta	APol	<i>Platynereis bicanaliculata</i>			1				
18	Annelida	Polychaeta	APol	<i>Polydora</i> sp.				1			
19	Annelida	Polychaeta	APol	<i>Syllis</i> sp.				4			
20	Crustacea	Amphipoda	CAM	<i>Apocorophium acutum</i>			11				
21	Crustacea	Amphipoda	CAM	<i>Caprella californica</i>					5		★
22	Crustacea	Amphipoda	CAM	<i>Caprella equilibra</i>	1						
23	Crustacea	Amphipoda	CAM	<i>Crassikorophium crassicornae</i>	1						
24	Crustacea	Amphipoda	CAM	<i>Erichthonius pugnax</i>		1	2	1			
25	Crustacea	Amphipoda	CAM	<i>Jassa slatteryi</i>			99		38		★
26	Crustacea	Amphipoda	CAM	<i>Marea</i> sp.				4			
27	Crustacea	Amphipoda	CAM	<i>Melita hoshinoi</i>				1			
28	Crustacea	Amphipoda	CAM	<i>Melita koreana</i>				1		★	
29	Crustacea	Amphipoda	CAM	<i>Monocorophium acherusicum</i>	1	1	4	1			
30	Crustacea	Amphipoda	CAM	<i>Pareurystheus anamae</i>	1						
31	Crustacea	Amphipoda	CAM	<i>Photis reinhardi</i>			1				
32	Crustacea	Isopoda	CIs	<i>Cirolana koreana</i>			10	12	1	★	
33	Crustacea	Isopoda	CIs	<i>Dynoides dentisinus</i>					1		
34	Crustacea	Isopoda	CIs	<i>Paranthura japonica</i>				1			
35	Crustacea	Cirripedia	CCi	<i>Amphibalanus amphitrite</i>	785	219	2,467	3,536			★
36	Crustacea	Cirripedia	CCi	<i>Amphibalanus improvisus</i>		260	7	548			★
37	Crustacea	Cirripedia	CCi	<i>Balanus trigonus</i>		53	1,938	381	1,389	★	
38	Crustacea	Cirripedia	CCi	<i>Conchoderma auritum</i>	15						
39	Crustacea	Cirripedia	CCi	<i>Fistulobalanus kondakovi</i>	6					★	
40	Crustacea	Cirripedia	CCi	<i>Lepas anatifera</i>					1		
41	Crustacea	Decapoda	CDe	<i>Hemigrapsus sinensis</i>				1			
42	Crustacea	Decapoda	CDe	<i>Philemnus minutus</i>			1				
43	Crustacea	Tanaidacea	CTa	<i>Zeuxo</i> sp1			26		6		
44	Chordata	Tunicata	CTu	<i>Ascidia</i> sp.					2		
45	Chordata	Tunicata	CTu	<i>Pyura</i> sp.			32				
46	Chordata	Tunicata	CTu	<i>Styela clava</i>			9		4		
47	Platyhelminths	Planoceridae	Plat	<i>Planocera reticulata</i>			2	27			
No. of species					7	9	25	19	18	6	8
No. of individuals (ind.)					817	564	5,240	4,605	2,371		
Biomass (gWWt)					70.9	9.4	1,374.9	1,086.5	579.8		
No. of samples (15x15 cm)					14	13	16	12	14		

Supplementary Table S5. Similarity percentage (SIMPER) results showing the average abundance, the average dissimilarity, the percentage contribution of each species to the dissimilarity among the vessel community groups, the percentage cumulative dissimilarity, and the average dissimilarity of the groups (Group A: Isabu, Group B: Onnuri, Group C: Jangmok 1, Group D: Eardo and Jangmok 2).

Species	Av. Abund.	Av. Abund.	Av. Diss.	Contrib. %	Cum. %	Group Av. Diss. %
	Group A	Group B				
<i>Amphibalanus improvisus</i>	0.0	4.0	12.9	18.6	18.6	69.0
<i>Balanus trigonus</i>	0.0	2.7	8.6	12.5	31.1	
<i>Conchoderma auritum</i>	2.0	0.0	6.3	9.1	40.3	
	Group A	Group C				
<i>Amphibalanus improvisus</i>	0.0	4.8	9.4	12.5	12.5	75.5
<i>Balanus trigonus</i>	0.0	4.4	8.6	11.4	23.9	
<i>Magallana gigas</i>	0.0	2.7	5.2	6.8	30.7	
<i>Amphibalanus amphitrite</i>	5.3	7.7	4.7	6.2	36.9	
	Group A	Group D				
<i>Balanus trigonus</i>	0.0	6.4	11.1	12.3	12.3	90.6
<i>Magallana gigas</i>	0.0	4.2	7.3	8.1	20.3	
<i>Hydroides ezoensis</i>	0.0	3.9	7.0	7.7	28.1	
<i>Amphibalanus amphitrite</i>	5.3	3.5	6.6	7.3	35.4	
<i>Mytilus galloprovincialis</i>	0.0	3.2	5.6	6.2	41.6	
	Group B	Group C				
<i>Amphibalanus amphitrite</i>	3.9	7.7	6.8	13.2	13.2	51.3
<i>Planocera reticulata</i>	0.0	2.3	4.0	7.8	21.0	
<i>Nereis multignatha</i>	0.0	2.0	3.5	6.7	27.8	
<i>Cirolana koreana</i>	0.0	1.9	3.3	6.4	34.1	
<i>Balanus trigonus</i>	2.7	4.4	3.0	5.9	40.0	
	Group B	Group D				
<i>Balanus trigonus</i>	2.7	6.4	5.8	8.9	8.9	64.8
<i>Amphibalanus amphitrite</i>	3.9	3.5	5.7	8.8	17.7	
<i>Amphibalanus improvisus</i>	4.0	0.8	5.3	8.1	25.9	
	Group C	Group D				
<i>Amphibalanus amphitrite</i>	7.7	3.5	5.5	8.9	8.9	61.6
<i>Amphibalanus improvisus</i>	4.8	0.8	4.9	8.0	16.9	
<i>Hydroides ezoensis</i>	0.0	3.9	4.8	7.7	24.6	
<i>Mytilus galloprovincialis</i>	0.0	3.2	3.8	6.2	30.9	

Supplementary Table S6. One-way ANOSIM pairwise tests for differences between vessel groups for hull-fouling macroinvertebrates (Global R = 0.532, $p < 0.001$).

Vessel clusters	R statistic	Significance level (p)	Possible permutations	Actual permutations	Number \geq Observed
Isabu vs. Onnuri	0.34	0.029	35	35	1
Isabu vs. Eardo	0.35	0.057	35	35	2
Isabu vs. Jangmok 1	1.00	0.029	35	35	1
Isabu vs. Jangmok 2	1.00	0.029	35	35	1
Onnuri vs. Eardo	0.08	0.229	35	35	8
Onnuri vs. Jangmok 1	0.32	0.029	35	35	1
Onnuri vs. Jangmok 2	0.39	0.029	35	35	1
Eardo vs. Jangmok 1	0.46	0.029	35	35	1
Eardo vs. Jangmok 2	0.64	0.029	35	35	1
Jangmok 1 vs. Jangmok 2	1.00	0.029	35	35	1

Supplementary Table S7. Spearman rank correlation (ρ) of the variables of the biological indices and operating conditions of vessels (Abbreviations: TODs, total operation days; TADs, total anchoring days; CODs, coastal operation days; OODs, ocean operation days).

Variables	No. of species	No. of individuals	Biomass	H'	J'	TOD	TAD	COD
No. of species								
No. of individuals (ind./m ²)	0.760***							
Biomass (gWWt./m ²)	0.755***	0.755***						
H'(loge), Diversity index	0.742***	NS	0.48*					
J', Evenness index	NS	NS	NS	0.82***				
Total operation days (TODs)	NS	NS	NS	-0.625**	-0.576**			
Total anchoring days (TADs)	NS	NS	NS	0.625**	0.576**	-1***		
Coastal operation days (CODs)	0.668**	0.658**	0.686**	0.507*	NS	-0.671**	0.671**	
Ocean operation days (OODs)	-0.668**	-0.658**	-0.686**	-0.507*	NS	0.671**	-0.671**	-1***

Significance level alpha = 0.05 (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, NS: non-significant)

Supplementary Appendix S1. Hull-fouling macroinvertebrate specimens identified to species on the Isabu research vessel.

[illegible]

Supplementary Appendix S2. Hull-fouling macroinvertebrate specimens identified to species on the Onnuri research vessel.

[illegible]

Supplementary Appendix S5. Hull-fouling macroinvertebrate specimens identified to species on the Jangmok 2 research vessel.

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