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COMMUNITY LOSS OF THE LOOSE-LYING RED ALGAE THROUGH THE MACROALGAL BEACH CASTS IN VÄINAMERI AREA

MSc thesis

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CONTENT

INTRODUCTION

The sea area of West Estonian Archipelago hosts the largest known mixed community of loose-lying *Furcellaria lumbricalis* (Huds.) Lamour and *Coccotylus truncatus* (Pall.) Wynne & Heine. The community covers up to 120 km^2 of sea bottom and forms more than 140 000 tons of biomass in Kassari Bay (Martin *et al*., 2006). Commercial importance of the red alga *F. lumbricalis* is due to polysahharides technologically extracted from the thallus (Tuvikene *et al*., 2006; Truus *et al*., 1996; Bird *et al*., 1991). The industrial exploitation of the community started in Saaremaa Island in 1966. The state of the drifting algal community is monitored since the beginning of industrial exploitation but only recently the investigations explaining the biomass formation and community fluctuation were started.

Previously, the marine wracks in the Väinameri area were observed by Trei (1965, 1968). More recent studies on the shores of Saaremaa Island were made in 1976–1982 (Martin *et al*., 1996). Unfortunately no information on methods used while estimating the amount of wrack in these studies is available.

The present investigation was prompted by lack of the relevant information about algal biomass losses by natural forces. The aim of the master's thesis are (1) to estimate natural losses of the community thought cast ashore and (2) to compare these amount with commercially harvested biomass of the community.

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MATERIAL AND METHODS

STUDY AREA

Kassari Bay (also Hiiu Strait) extend more than 600 km^2 (Mardiste, 1974) and is a relatively isolated from the Baltic Proper and other regions of the Väinameri (the inner sea of the West Estonian Archipelago). According to the EMHI archive ice cover lasts on average 100 days in Kassari Bay. Salinity is typically between 6.0–6.7 PSU (Suursaar et al., 2000).

Two shore types dominate: till shore and gravel-pebble shore (Orviku, 1993). The bottom of the bay is relatively flat (Mardiste, 1970) as the isobath of 5 m lies at 0.5–1 km from the studied coastal sites in the NE of Saaremaa Island. Less than half of the sea area is less than 5 m deep.

The loose-lying red algal communities cover about 120 km^2 surface area recently (Kersen, 2006). Circular currents and bottom morphology keep the unattached red algae community drifting away from the region. These communities are found at the depth range of 5–9 m mainly on clay and sand bottoms.

FIELD WORKS

Field data for present study were collected on the sampling sites in the NE coast of Saaremaa Island from 21.04 to 05.11 in 2002 (Fig. 1):

1) 58,5863°N ; 22,7642°E (Mujaste Village, Leisi Parish; in tables & figures: T1);
2) 58,6222°N ; 22,8658°E (Rannaküla Village, Orissaare Parish; in tables & figures: T2);
3) 58,6145°N ; 22,9062°E (Jaani Village, Orissaare Parish; in tables & figures: T3).

The sites were visited monthly during the ice-free season (seven times in all). Firstly, the visual observations of the wrack were done to clarify whether new macroalgae have been accumulated on the shore. In the case of new wrack, they were described (location and taxonomic composition), measured (length and width of the wrack) and video recorded. The biomass samples were taken only when the unattached form of *F. lumbricalis* was found.

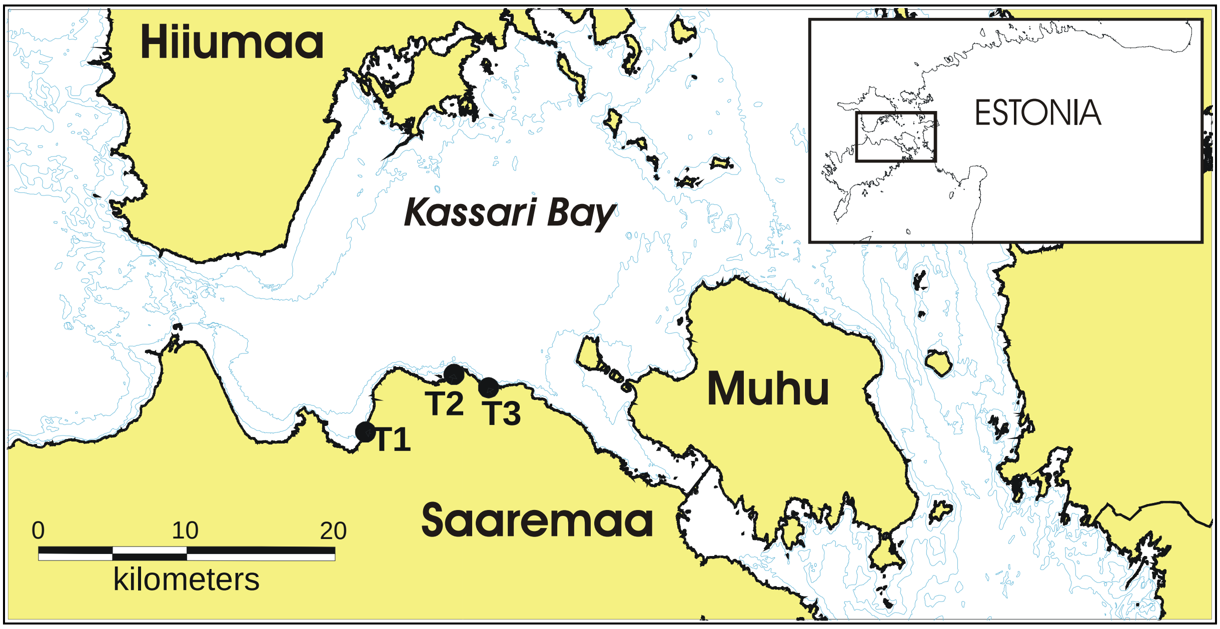

Fig. 1. Location of the study area in 2002. Study sites are indicated by filled circles (T1, T2, T3). Bright fine lines mark isobaths in Väinameri area.

In each study site three replicate coastal sections were studied. The average length of the section was about 49–67 m long. One sample was randomly taken within each replicate section (quadrate frame, 20 × 20 cm, n = 32). The collected flora was packed, labeled and then deep-frozen at –18 °C.

LABORATORY WORKS

Three floristic components were separated: *F. lumbricalis*, *C. truncatus* and other macrophytes jointly. The latter was estimated only qualitatively. Determination was made according to the keys of Trei (1991) and Leht (1999). The species list of macrophytobenthos follows the nomenclature presented in Nielsen *et al*. (1995). Specimens were dried at 60 °C until constant dry weights two weeks (accuracy ±0.1 mg). The dry mass/volume ratio of the red algae *F. lumbricalis* and *C. truncatus* in the sampling frame (dry weight divided by volume; i.e. "bulk density") was used to calculate the biomass of the shore casts (g/m). Due to unequal interval of observations the biomasses were divided with the number of days between data collections.

DATA ANALYSIS AND STATISTICAL MODEL

Distances between the three sampling sites and the upper distribution limit of loose-lying algal community were measured (according to the biomass distribution area estimates in summer 2002; see Fig. 1). Nonlinear multiple regression analysis was used to describe the functional relationship between average wind speed (m/s), distance between community and sampling sites, and wrack biomass (g/m) (data are presented in Appendix 2**)**.

Shoreline and basin border were divided into 24 sections wherein average distances between the edge of the red algal community and each section were measured. Some sections were directly located at Soela Strait, Hiiumaa Islets and around Kõinastu Islets (Fig. 2). The length of shoreline was measured with a step of 500 meters at the chart (*Soela Strait*…, 2001).

Prior to analysis the data were transformed due to an occurrence of non-linear relations (squared and/or multiplied, if such interactions were expected). Appropriate statistical model was constructed by means of stepwise regression analysis (StatSoft Inc., 2004) describing the relationships between wrack accumulation and environmental parameters.

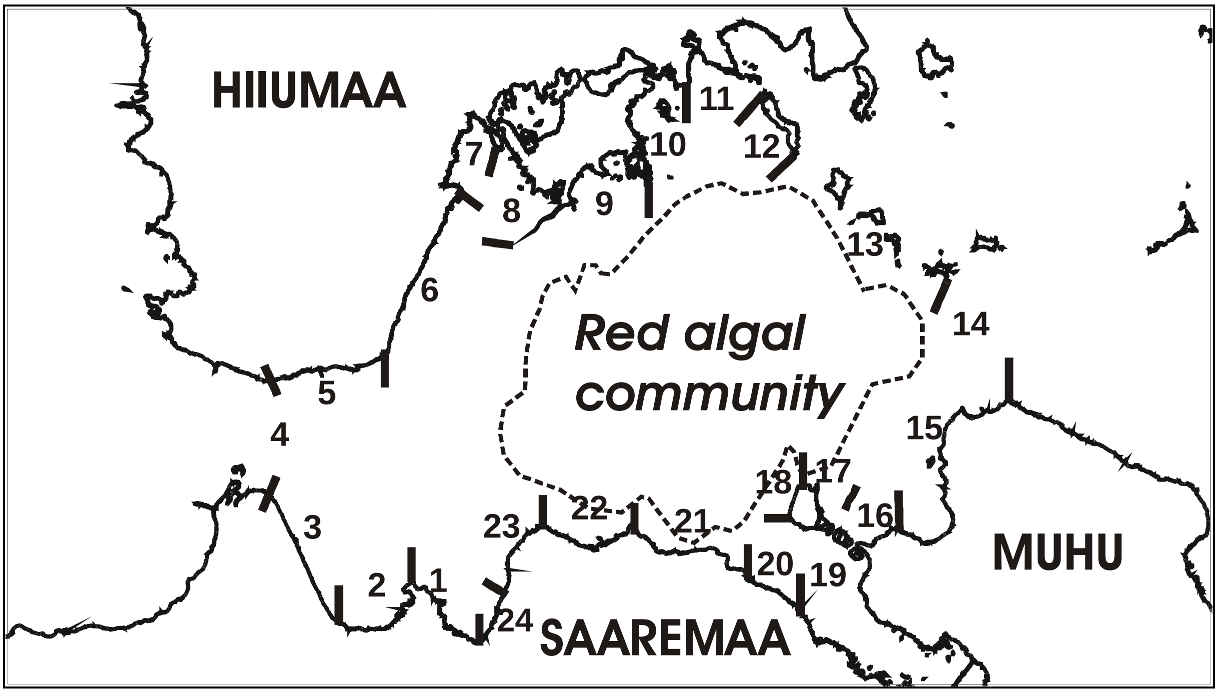

Fig. 2. Division of the Kassari Bay area into 24 sections (indicated as black sticks). The length of sea areas (4, 14, and 19) were measured directly, the rest coastline by a step of 500 m. Dotted line marks edge of algal community distribution area at state of 2002 summer.

The forms of the statistical models were as follows:

$$F = 5577.485\ T^2 - 36472.5\ T + 0.386441\ K - 0.1204458\ K\ T + 59395.78 \qquad (1)$$

where F – biomass of *F. lumbricalis* (g/m),

K – average distance from community edge (m),

T – average wind speed (m/s).

$$C = 2598.911\ T^2 - 16890.5\ T + 0.333485\ K - 0.104652\ K\ T + 27344.49 \qquad (2)$$

where C – biomass of *C. truncatus* (g/m),

K and T as in previous model.

Based on these equations the wrack biomasses of *F. lumbricalis* and *C. truncatus* for each intersampling periods (6 total) and sections (24 totals; Fig. 2.) were calculated (see Appendix 3**).** Using spatial extrapolation, the dry weights of beach-cast macroalgae for every section were calculated by multiplying the wrack biomass (g/m) by the length of the shoreline (132 km). Total wrack biomass accumulated during the study period was obtained when the values of dry weights were summed and transformed to wet weight (by ratio of 1:5; according to our measurements and analogous to Greenwell *et al*., 1984).

The aim of the study was to evaluate the natural losses of the loose-lying red algal community during the whole year of 2002. Therefore, we had to use temporal extrapolation, both retrospective and perspective. 197 days were covered by observations and 168 days were not, respectively. According to ice charts (EMHI archives) the dates of ice break-up and ice formation were 27.02.2002 and 09.12.2002, respectively. Thus, the ice-free period not covered by observations was 85 days in 2002.

We assumed that the wind characteristics prior to 21.04 and after 05.11 were similar to the adjacent studied periods. The biomass of the red algal beach cast (for simplification equated with natural losses) was calculated as follows: daily accumulation of the biomass of wrack during the first or last study period multiplied by the numbers of days extending the study period. The beach casts were considered negligible during the period of ice cover.

RESULTS AND DISCUSSION

FIELD OBSERVATION

Wrack accumulation

Fresh wrack (beach cast macroalgae) were observed at every sampling. The wrack included *F. lumbricalis* at five times (see Appendix 1). Storm casts in August and September were lacking *F. lumbricalis* in connection with unfavorable winds (mostly from S-directions). The accumulations values varied strongly and were highest in April. However, these values reflected the whole period between the break-up of ice (27.02) and the first sampling occasion (21.04). There is a possibility that this measurements included also beach casts from the previous periods since autumn 2001. The wrack of *F. lumbricalis* accumulated slightly or was missing between May and September which resemble an analogous accumulation pattern in Nuevo Gulf in Southern Hemisphere (Piriz *et al*., 2003).

The formation of wracks varied at wide ranges both by areal biomasses and spatial coverage. The wrack was found as a from of regular and homogenous ridges/mounds to fragmented single blotches. The width of wracks varied between 0.02–30 m and the thickness between 0.002–0.5 m. The average dimensions of the wacks at the sampling points are shown in Appendix 1.

Taxonomic composition and biomass

A total of 32 macrophyte biomass samples were analysed. Altogether 14 taxa were recorded throughout study period: 5 species of red, 2 species of brown, 2 species of green algae, 1 species of charophyte, 5 species of flowering plants and 3 macrozoobenthos taxa, respectively (Table 1).

Table 1. List of the species occurred in the beach-cast wracks in 2002.

Species	Recording level		
RHODOPHYTA			
Ceramium sp.	V	P	
Coccotylus truncatus		P	B
Furcellaria lumbricalis	V	P	B
Polysiphonia fucoides		P	
Rhodomela confervoides		P	
PHAEOPHYTA			
Fucus vesiculosus	V	P	
Pilayella littoralis		P	
CHLOROPHYTA			
Cladophora glomerata	V	P	
Enteromorpha intestinalis		P	
CHAROPHYTA			
Chara aspera	V	P	
MAGNOLIOPHYTA			
Myriophyllum spicatum	V	P	
Potamogeton sp.	V	P	
Ruppia maritima		P	
Zostera marina	V	P	
GASTROPODA			
Hydrobia sp.	V		
BIVALVIA			
Mytilus edulis	V		
Macoma balthica	V		

V - recorded in wracks (by observation)
P - recorded in samples (by laboratory determination)
B - biomass calculated

Most relevant taxonomical components of the wrack samples are given in Fig. 3.

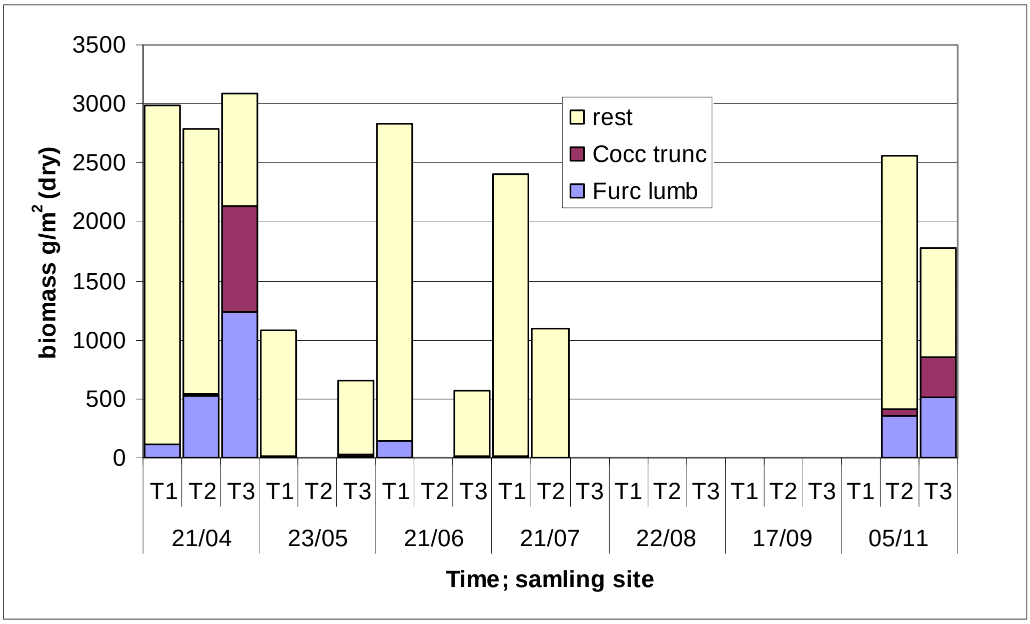

Fig. 3. The average biomass of the wracks by floristic component in three sampling sites in 2002.

The proportion of the red algae *F. lumbricalis* and *C. truncatus* in biomass samples varied between 0.3–39.9% and 0.1–29.2%, respectively. The highest percentage of both algae was found in April. The average annual taxonomic composition of the wracks is described in Fig. 4.

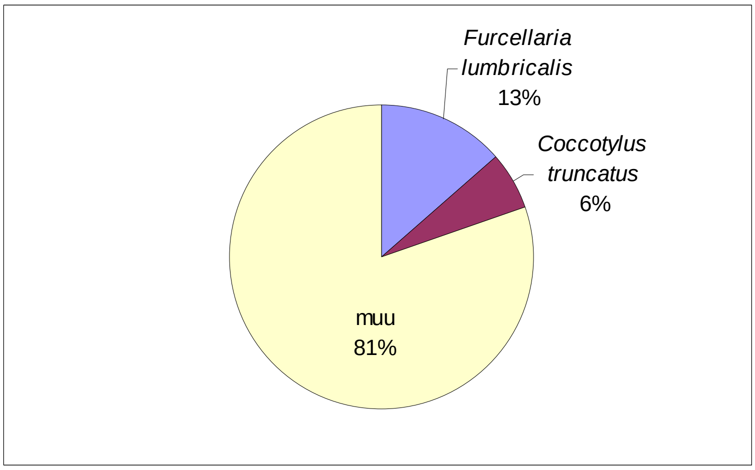

Fig. 4. Floristic composition of the wrack in the NE coast of Saaremaa Island. Muu = other macrophytes

The red algae *F. lumbricalis* and *C. truncatus* accumulated on shores at a rate of 1601 g dw/m and 668 g dw/m, respectively. The highest amounts of above-mentioned taxa accumulated in the last intersampling period (Fig. 5). As the intersampling periods had no equal duration, the accumulated wrack was divided by the number of days in each period in order to present the seasonality in the wrack accumulation (see Fig. 6).

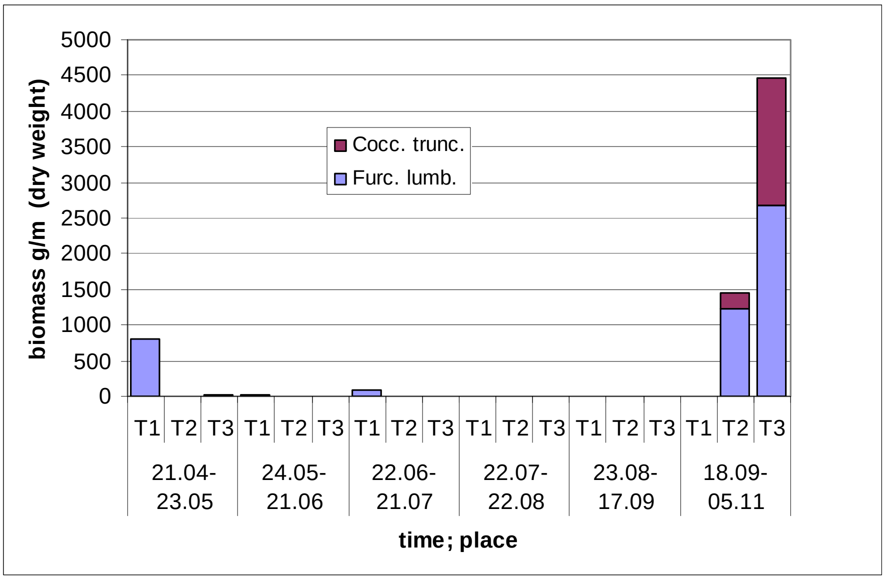

Fig. 5. Wrack accumulation of the dominant species at three sites during the study period.

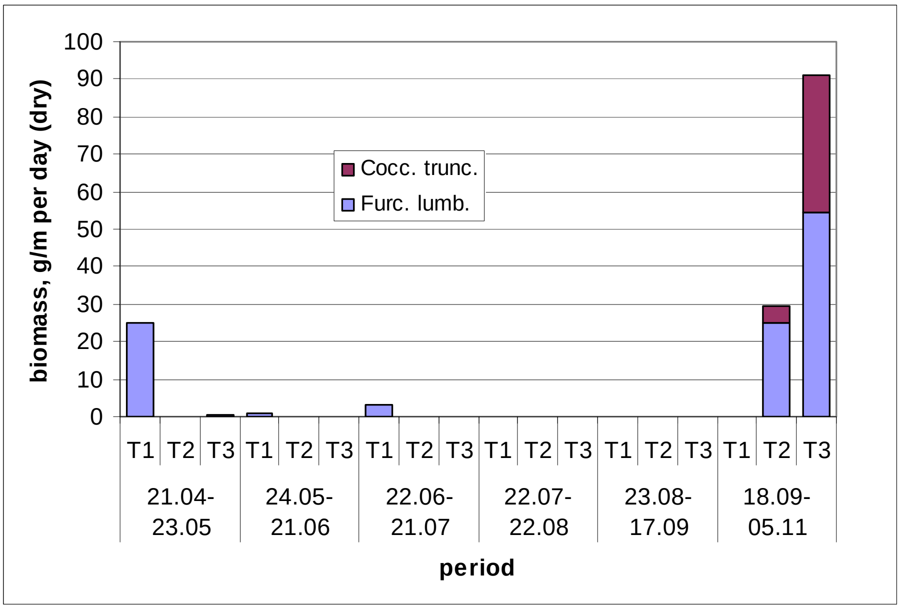

Fig. 6. The daily wrack accumulation of the dominant species at three sites during the study period.

STATISTICAL MODEL CALCULATION OF BIOMASS LOSSES

The biomasses of *F. lumbricalis* and *C. truncatus* were positively correlated with wind speed and distance from the red algal community. The models were relatively good (r = 0.59 for *F. lumbricalis* and r = 0.51 for *C. truncates*; $p < 0.05$), although the sample size was poor (n = 18) and biomass varied in wide ranges at 0–2676.1 g/m.

The loose-lying algae *F. lumbricalis* and *C. truncatus* were cast ashore at the same time periods and rates. Very strong linear correlation between the biomasses of these taxa in the wrack (R^2 = 0.85) suggests that the algae responded similarly to hydrodynamic conditions.

According to our statistical model, the red alga *F. lumbricalis* was mainly cast ashore in autumn (see Fig. 7) when N- and NE-winds were prevailing. Relatively large wracks were sporadically recorded in summer. In general those wracks did not consist of *F. Lumbricalis*, but mainly *Zostera marina* (formerly also the dominant wrack taxa (Trei, 1965)), *Fucus vesiculosus* and *Potamogeton pectinatus*.

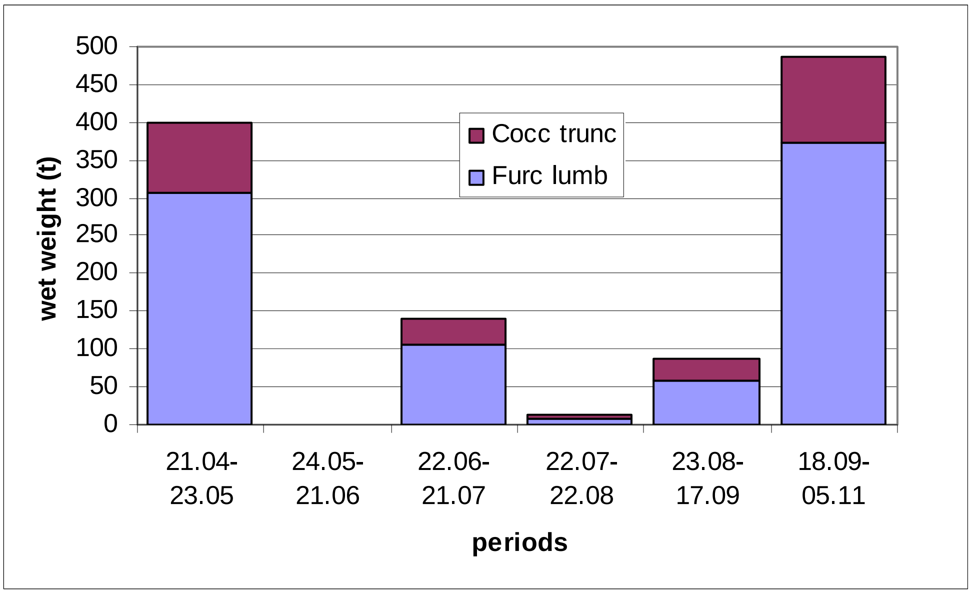

Fig. 7. Natural losses of the red algae through the beach-casts calculated by regression equations in the study period (21.04 to 05.11) separately for both dominant taxa: Cocc tunc – *C. truncatus*: Furc lumb – *F. lumbricalis*.

The wrack formation of *F. lumbricalis* and *C. truncatus* in April-November was estimated at 850 tons and 300 tons in wet weight, respectively (q.v. Fig. 7). During the remaining ice-free season (85 days) the algal biomass amounted 600 and 200 tons, including the first sampling occasion on the April 21st.

Thus, the total annual losses of red algal community through the storm casts were estimated at 2000–4000 tons in wet weight. Therefore it is commercially advisable to harvest storm casts from the shores of the Väinameri area in addition to traditional harvesting of red algal stocks. The losses were strongly related to the meteorological and hydrological conditions in the area.

The losses due to beach cast made up approximately 2% of annual production of the algal community (Kersen & Martin, 2005; Martin *et al.*, 2006a). The annual losses due to dredging are only about 20% of the losses due to beach cast (Kersen, 2005a). The community loss through beach casts depend mainly on wind velocity and direction, bottom and surface currents, wave activity and ice conditions.

SUMMARY

Unique, the largest known commercially usable loose-lying red algal community in the Baltic Sea is situated in Kassari Bay, the Väinameri Archipelago Sea. These macroalgae have been harvested since 1960s and continuous monitoring of biological characteristics of the community was carried out to enable sustainable exploitation of these marine living resource.

In this study the losses of the red algal community through beach casts were computed from the estimates in the amounts of marine wrack on the NE shores of Saaremaa Island from April to November 2002. The community loss through beach casts we estimated at 2000–4000 tons wet weight per year and it depended strongly on meteorological and hydrological conditions in the study area. Natural losses made up approximately 2% of annual growth rate of the algal community. The annual dredging contributed only 20% of the losses due to beach cast.

KOKKUVÕTE

Kinnitumata punavetikakoosluse biomassi kadu mereheidiste akumulatsiooni tulemusena Väinameres

Priit Kersen

Läänemere suurim teadaolev vabalt lebav tööndusliku tarbitav kinnitumata punavetikakooslus asub Kassari lahes Väinameres. Kõnealuseid vetikavarusid on välja püütud alates 1960ndatest aastatest. Koosluses kasvav punavetikas agarik (*Furcellaria lumbricalis*) on väärtuslik tooraine geelistuvate polüsahhariidide tootmises. Kõnealune punavetikakooslus on maailmas unikaalne leviala ulatuse ja põhja kohal vabalt lebava (kinnitumata) eluvormi poolest. Sarnaseid varusid esineb tööndulikes kogustes veel vaid Kanada rannikuvetes. Mujal Läänemeres on taolised varem esinenud kooslused tugevalt kahjustatud või koguni hävinud.

Käesolevas töös on uuritud punavetikakoosluses esinevaid biomassi kadusid mereheidiste akumulatsiooni kaudu. Looduslikke kadusid on arvutatud kooslusest väljauhtumise kaudu Saaremaa kirderanniku vaatlusjaamade põhjal aprillist novembrini 2002. aastal. Looduslikke kadusid kooslusest väljauhtumise tulemusena hinnati 2000–4000 tonni märgkaalus aastas, mis sõltus oluliselt vaatluspiirkonnas valitsevatest meteoroloogilistest ja hüdroloogilistest tingimustest. Looduslikud kaod moodustavad punavetikakoosluse aastasest produktsioonist hinnanguliselt 2%. Aasta jooksul randa uhutud kinnitumata punavetikakooslusest pärit mereheidised ületavad väljapüütava vetikasegu kogust *ca* 5 korda.

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APPENDIXES

APPENDIX 1

Wrack sampling data at the three study sites in the NE coast of Saaremaa Island

Date	Location	Section length (m)	Avg. length of ridge (m)	Avg. thickness of ridge (m)	Biomass sampling		Biomass of sample (g, dry):		
					Repetition	Thickness (m)	*Furcellaria lumbricalis*	*Coccotylus truncatus*	Total
21.04.02	T1	62.3	4.6	0.26	1	0.13	5.56	0	145.04
					2	0.12	5.05	0	106.01
					3	0.08	2.77	0	107.20
	T2	49.5	1.1	0.25	1	0.1	18.85	0.27	128.51
					2	0.05	26.39	0.30	93.40
					3	0.11	17.61	0.77	112.47
	T3	51.4	15.1	0.34	1	0.1	49.85	32.52	121.36
					2	0.09	51.25	41.71	124.34
					3	0.12	46.91	34.22	124.81
23.05.02	T1	49	15.5	0.02	1	0.02	*Furcellaria lumbricalis* absent		
					2	0.02	1.09	0	44.52
					3	0.02	0.97	0	43.04
	T2	*Furcellaria lumbricalis* absent							
	T3	51.4	0.45	0.01	1	0.01	0.46	0.57	22.37
					2	0.01	1.06	0.78	29.59
					3	0.01	0.80	0.50	26.82
21.06.02	T1		0.2		1		2.84	0.11	70.05
					2		2.35	0	68.60
					3		12.11	0.23	201.07
	T2	*Furcellaria lumbricalis* absent							
	T3		0.15		1		0.47	0.09	15.30
					2		0.08	0.06	14.14
					3		0.95	0.22	38.51
21.07.02	T1	57.7	3.9	0.04	1	0.02	1.14	0	71.35
					2	0.035	0.60	0	104.73
					3	0.03	0.40	0	113.08
	T2	49.5	0.125	0.015	1	0.015	0.04	0	13.36
					2	0.015	0.06	0	31.02
					3	0.015	0.33	0	86.97
	T3	*Furcellaria lumbricalis* absent							
22.08.02	*Furcellaria lumbricalis* absent								
17.09.02	*Furcellaria lumbricalis* absent								
05.11.02	T1	*Furcellaria lumbricalis* absent							
	T2	67	3.2	0.14	1	0.25	32.44	5.47	206.27
					2	0.13	8.33	1.10	86.56
					3	0.02	1.78	0.64	13.92
	T3	66	4.3	0.1	1	0.05	6.58	6.00	31.85
					2	0.06	11.74	8.28	40.79
					3	0.08	42.75	26.33	140.01

APPENDIX 2

Variables used in regression analysis to calculate (extrapolate) wrack biomasses over the whole bay area.

Period	*Avg. wind speed (m/s)	Location	Distance from community (m)	Wrack accumulation (g/m)	
				Furcellaria lumbricalis	*Coccotylus truncatus*
21.04–23.05	3.714	T1	7700	795.8	0
		T2	1000	0	0
		T3	300	8.7	6.9
24.05–21.06	3.400	T1	7700	0	0
		T2	1000	0	0
		T3	300	1.9	0.5
22.06–21.07	3.611	T1	7700	93.7	0
		T2	1000	0.04	0
		T3	300	0	0
22.07–22.08	3.104	T1	7700	0	0
		T2	1000	0	0
		T3	300	0	0
23.08–17.09	3.060	T1	7700	0	0
		T2	1000	0	0
		T3	300	0	0
18.09–05.11	3.741	T1	7700	0	0
		T2	1000	1226.9	214
		T3	300	2676.1	1779.1

*in Virtsu station, measured by EMHI

APPENDIX 3

Calculated amounts of wrack biomass for every 24 shoreline sections in the area of Kassari Bay

Period	Wind speed (m/s)	Section nr	Length (m)	Distance from community (m)	*F. lumbricalis* (g/m)	*F. lumbricalis* (g)	*C. truncatus* (g/m)	*C. truncatus* (g)
1	2	*3*	*4*	*5*	*6*	*7*	*8*	*9*
21.04-23.05	3.714	1	4800	8000	383	1840558	20	96417
	3.714	2	5000	10000	262	1308602	0	0
	3.714	3	7500	12000	140	1049935	0	0
	3.714	4	5400	12200	128	690219	0	0
	3.714	5	5600	9900	268	1499719	0	0
	3.714	6	8700	7400	420	3653725	53	462724
	3.714	7	5500	7500	414	2276351	48	262185
	3.714	8	5500	6000	505	2778484	130	717308
	3.714	9	7500	3600	651	4884404	263	1971141
	3.714	10	6600	4000	627	4137593	241	1588965
	3.714	11	4800	4100	621	2979943	235	1129131
	3.714	12	3000	2400	724	2172874	329	987055
	3.714	13	15400	1000	810	12466327	406	6256272
	3.714	14	5500	2200	736	4050553	340	1870285
	3.714	15	9400	4500	596	5606872	213	2003790
	3.714	16	2300	3600	651	1497884	263	604483
	3.714	17	3000	1200	797	2391987	395	1185654
	3.714	18	1800	1700	767	1380414	368	661743
	3.714	19	4200	3300	670	2811956	279	1173349
	3.714	20	3000	3600	651	1953762	263	788457
	3.714	21	6600	1000	810	5342712	406	2681259
	3.714	22	5100	1600	773	3942213	373	1903073
	3.714	23	3200	4500	596	1908722	213	682141
	3.714	24	2600	7200	432	1123567	64	166972
24.05-21.06	3.400	1	4800	8000	0	0	0	0
	3.400	2	5000	10000	0	0	0	0
	3.400	3	7500	12000	0	0	0	0
	3.400	4	5400	12200	0	0	0	0
	3.400	5	5600	9900	0	0	0	0
	3.400	6	8700	7400	0	0	0	0
	3.400	7	5500	7500	0	0	0	0
	3.400	8	5500	6000	0	0	0	0
	3.400	9	7500	3600	0	0	0	0
	3.400	10	6600	4000	0	0	0	0
	3.400	11	4800	4100	0	0	0	0
	3.400	12	3000	2400	0	0	0	0
	3.400	13	15400	1000	0	0	0	0
	3.400	14	5500	2200	0	0	0	0
	3.400	15	9400	4500	0	0	0	0
	3.400	16	2300	3600	0	0	0	0
	3.400	17	3000	1200	0	0	0	0
	3.400	18	1800	1700	0	0	0	0
	3.400	19	4200	3300	0	0	0	0

APPENDIX 3. *CONTINUED*

1	2	3	4	5	6	7	8	9
	3.400	20	3000	3600	0	0	0	0
	3.400	21	6600	1000	0	0	0	0
	3.400	22	5100	1600	0	0	0	0
	3.400	23	3200	4500	0	0	0	0
	3.400	24	2600	7200	0	0	0	0
22.06-21.07	3.611	1	4800	8000	33	159544	0	0
	3.611	2	5000	10000	0	0	0	0
	3.611	3	7500	12000	0	0	0	0
	3.611	4	5400	12200	0	0	0	0
	3.611	5	5600	9900	0	0	0	0
	3.611	6	8700	7400	62	542494	0	0
	3.611	7	5500	7500	58	316265	0	0
	3.611	8	5500	6000	130	716629	0	0
	3.611	9	7500	3600	247	1850742	82	611566
	3.611	10	6600	4000	227	1500537	64	420835
	3.611	11	4800	4100	223	1068006	59	284726
	3.611	12	3000	2400	305	915001	135	404640
	3.611	13	15400	1000	373	5743289	197	3035457
	3.611	14	5500	2200	315	1730884	144	790733
	3.611	15	9400	4500	203	1909042	42	390464
	3.611	16	2300	3600	247	567561	82	187547
	3.611	17	3000	1200	363	1089705	188	564654
	3.611	18	1800	1700	339	610147	166	298789
	3.611	19	4200	3300	261	1097562	95	398482
	3.611	20	3000	3600	247	740297	82	244626
	3.611	21	6600	1000	373	2461410	197	1300910
	3.611	22	5100	1600	344	1753500	170	869237
	3.611	23	3200	4500	203	649887	42	132924
	3.611	24	2600	7200	72	187360	0	0
22.07-22.08	3.104	1	4800	8000	24	113395	25	122252
	3.104	2	5000	10000	49	243817	43	213733
	3.104	3	7500	12000	74	554271	60	450179
	3.104	4	5400	12200	76	412650	62	333458
	3.104	5	5600	9900	48	266036	42	234543
	3.104	6	8700	7400	16	139914	20	176489
	3.104	7	5500	7500	17	95365	21	116324
	3.104	8	5500	6000	0	0	8	45056
	3.104	9	7500	3600	0	0	0	0
	3.104	10	6600	4000	0	0	0	0
	3.104	11	4800	4100	0	0	0	0
	3.104	12	3000	2400	0	0	0	0
	3.104	13	15400	1000	0	0	0	0
	3.104	14	5500	2200	0	0	0	0
	3.104	15	9400	4500	0	0	0	0
	3.104	16	2300	3600	0	0	0	0
	3.104	17	3000	1200	0	0	0	0
	3.104	18	1800	1700	0	0	0	0
	3.104	19	4200	3300	0	0	0	0
	3.104	20	3000	3600	0	0	0	0
	3.104	21	6600	1000	0	0	0	0

APPENDIX 3. *CONTINUED*

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
	3.104	22	5100	1600	0	0	0	0
	3.104	23	3200	4500	0	0	0	0
	3.104	24	2600	7200	14	35277	19	48252
23.08-17.09	3.060	1	4800	8000	158	759760	101	483466
	3.060	2	5000	10000	194	970185	127	636109
	3.060	3	7500	12000	230	1723431	154	1152912
	3.060	4	5400	12200	233	1260177	156	844407
	3.060	5	5600	9900	192	1076597	126	705022
	3.060	6	8700	7400	148	1283748	93	807118
	3.060	7	5500	7500	149	821397	94	517534
	3.060	8	5500	6000	123	673913	74	408223
	3.060	9	7500	3600	80	597189	42	318170
	3.060	10	6600	4000	87	572721	48	314969
	3.060	11	4800	4100	89	425105	49	235428
	3.060	12	3000	2400	58	174519	27	79568
	3.060	13	15400	1000	33	510439	8	122783
	3.060	14	5500	2200	55	300287	24	131300
	3.060	15	9400	4500	96	899715	54	510866
	3.060	16	2300	3600	80	183138	42	97572
	3.060	17	3000	1200	37	110162	11	31869
	3.060	18	1800	1700	46	82187	17	31046
	3.060	19	4200	3300	74	311901	38	161480
	3.060	20	3000	3600	80	238876	42	127268
	3.060	21	6600	1000	33	218760	8	52621
	3.060	22	5100	1600	44	223745	16	81207
	3.060	23	3200	4500	96	306286	54	173912
	3.060	24	2600	7200	144	374353	90	234318
17.09-05.11	3.741	1	4800	8000	496	2380548	65	311032
	3.741	2	5000	10000	368	1838380	0	0
	3.741	3	7500	12000	239	1795533	0	0
	3.741	4	5400	12200	227	1223517	0	0
	3.741	5	5600	9900	374	2094902	0	0
	3.741	6	8700	7400	534	4649533	100	866550
	3.741	7	5500	7500	528	2904085	94	515914
	3.741	8	5500	6000	624	3433205	181	994485
	3.741	9	7500	3600	778	5836088	320	2400272
	3.741	10	6600	4000	752	4966439	297	1959096
	3.741	11	4800	4100	746	3581170	291	1396953
	3.741	12	3000	2400	855	2565324	390	1168940
	3.741	13	15400	1000	945	14551431	471	7251223
	3.741	14	5500	2200	868	4773643	401	2206866
	3.741	15	9400	4500	720	6771975	268	2517588
	3.741	16	2300	3600	778	1789734	320	736083
	3.741	17	3000	1200	932	2796213	459	1377771
	3.741	18	1800	1700	900	1620005	430	774455
	3.741	19	4200	3300	797	3349020	337	1417243
	3.741	20	3000	3600	778	2334435	320	960109
	3.741	21	6600	1000	945	6236327	471	3107667
	3.741	22	5100	1600	906	4622725	436	2223873
	3.741	23	3200	4500	720	2305353	268	857051
	3.741	24	2600	7200	547	1422866	111	289134