

# Merelindude asustustiheduste modelleerimine

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## Sissejuhatus

Käesolevas anname lühiülevaate distantsloendusandmetest asustustiheduse ruumilise modelleerimise meetodikast ja asustustiheduse rasterkaartide saamise protsessist.

## Metoodika

Distantsloendus (ik *distance sampling*) on laialt kasutatav andmekogumismeetod millega kogutakse infot liikide populatsioonide suuruse kohta. Distantsloendusel kogutud andmed võimaldavad hinnanta isendite asustustihedust ning prognoosida populatsiooni arvukuse hinnangut. Distantsloendusmeetodid jagunevad 1) joonloendusteks (ikline transect sampling) ja 2) punktloendusteks (ik point transect sampling).

Idealiseeritud juhul avaldub asustustihedus tegelike isendite arvu  $n$  ja tegelikult läbitud pindala  $a$  jagatisega.

$$\hat{D} = \frac{n}{a} \quad (1)$$

Praktikas on nii, et ideaalset loendust pole võimalik saavutada. Näiteks joonloenduse puhul väheneb isendite avastamise tõenäosus isendi kaugusest loendaja liikumistrajektorist e loendrajast. Mida kaugemal on isend, seda ebatõenäolisem on kontakti asetleidmine vaatleja ja liigi isendi vahel. Et hinnata läbitud ala ja veenduda, et leitakse kõik isendid, siis lahendusena kasutatakse fikseeritud loendusribaga loendamist (näiteks laiusega  $2w$ ). See tähendab, et loendatakse ainult need kontaktid, mis arvatakse avastatavat 100% kindlusega. Kuid ka fikseeritud loendusriba hoidmine on merel või maastikul liikudes on küllaltki tülikas. Kokkuvõtvalt, läbiuuritud pindala  $a$  ei saa hinnata konstantse loendusriba laiuse  $w$  põhjal ning ka tegelik isendite arv  $n$  kujuneb avastatavuse tõttu alahinnanguks. Edasine  $D$  hindamine taandub praktikas kontaktide avastamiskauguse jaotuse põhjal.

Praktikas mõõdetakse distantsloendusel isendi(te) lendutõusu kaugust (radiaalkaugus  $e$ ,  $\rho$ ) ning suunanurka ( $h$ ) või ristkaugust  $r$  või kaugusvahemikku. Ristkauguste jaotus näitabki tegelikult seda, kuidas väheneb rajajoonest eemaldudes isendite avastamise tõenäosus. Ristkauguste jaotuse normeerimisel saame sisuliselt tõenäosustiheduse, mida hindame funktsiooniga  $\hat{P}$ .  $\hat{P}$  avaldatakse läbi avastamisfunktsiooni  $f(r)$  (ik detection function), mis kirjeldab tõenäosustiheduse ja avastamiskauguse  $r$  vahelist sõltuvust.

Avastamisfunktsiooni lähenditena on kasutusel mitmeid, kuid praktikas on levinuim pool-Gaussi funktsioon (*half-normal*) ja nn *hazard-rate* funktsioon.

Distantsloenduse puhul kehtivad mõned olulised eeldused: 1) rajal avastatakse kõik isendid, ehk  $f(0)=1$ ; 2) isendid avastatakse nende esimeses asukohas; 3) kaugused määratakse täpselt; 4) erinevate isendite avastamise sündmused on sõltumatud.

## Andmetöötlus

Põhiline andmetöötlus seisnes algandmete tabelite korrastamises ja trükivigade eemaldamises. Peale andmete ühtlustamist koondati need ühtse struktuuriga andmetabelisse, mille formaat määrati R laienduse dsm vastavate funktsioonide sisendite põhjal.

Ruumiandmete ettevalmistamisel seisnes aastaaja loenduse kohta analüüsivõrkude genereerimist. Maskide põhjal eraldati hiljem kasutatud tunnusrastritest (meresügavus, kaugus rannast, jne) vajalikud rasterkihid. Neid kasutati hiljem asustustiheduse pinna mudeldamisel.

## Asustustiheduse ruumiline mudeldamine

Mudeldamise lõpp-produktiks on asustustiheduse rasterkaart. Täpsemalt kolm rasterkihti, mille piksli suurus kirjeldab: 1) tiheduse keskvaartust; 2) tiheduse alumist usalduspiiri; 3) tiheduse ülemist usalduspiiri. Viimased kaks arvutatakse asustustiheduse ruumimudeli standardvea hinangu põhjal vastavalt prognoosi keskvaartus  $\mp 1.96 \times SE$ .

Tiheduspinna mudeldamisel kasutatakse üldist additiivset segamudelit (GAM ik *Generalized Additive Model*). Mudeli andmeühikuks on lennuloendustranseksti 500 m pikkune lõik ehk segment. Segmentid ühtivad tunusrastrite pikslivõrguga so üks segment jääb ühe rastri piksli ülatusse. Mudeli prognoositavaks tunnuseks on tegeliku asustustiheduse hinanng. Tegeliku asustustiheduse hinanng  $\hat{D}$  leitakse tegeliku isendite arvu hinanngust segmendis  $\hat{N}_i$ , jagades see efektiivse pindalaga, mis avaldub kahekordse efektiivse poolriba laiuse ja segmendi pikkuse korrutisega  $S_i = 2Lw \times 500$ . Efektiivne poolriba laius saadakse avastamisfunktsiooni lähendist. Kui segmendis loendati  $c_i$  parve, siis tegeliku isendite arvu hinanng segmendis  $N_i$  avaldub läbi parve suuruse  $\hat{n}_{ij}$  ja parve avastamistõenäosuse  $\hat{p}_{ij}$ .

$$\hat{N}_i = \sum_{j=1}^{c_i} \frac{\hat{n}_{ij}}{\hat{p}_{ij}} \quad (2)$$

Additiivsetes mudelites kasutati järgmisi tunnuseid: 1) x ja y koordinaat (kahemõõtmeline "pinnatunnus"); 2) mere sügavus meetrites; 3) parve augus rannikust meetrites; 4) parve kaugus lähimast laevast meetrites. Nendest tunnuste kombineerimisel saadi kandidaatmudelid, millest valiti iga liigi puhul välja parim mudel vastavalt AIC kriteeriumile (vähim on parim).

Avastamisfunktsiooni hindamisel loodi samuti hulk kandidaatmudeleid. Kasutati tunnuseid: 1) päikesepaiste (sun); 2) lainetus (wav); 3) nähtavus (vis); 4) jääkatte iseloom (ice); 5) vaatlaja (obs). Lisaks tekitati eelnenud tunnustest kombinatsioone ning prooviti kas h-rate või h-norm lähendit. Parim avastamismudel valiti kandidaatmudelitest vastavalt AIC kriteeriumile so mida väiksem seda parem.

Arvutused viidi läbi R laienduse Distance ja dsm abil.

Arvukuse hinnangud leiti asustustiheduste prognooskaartide põhjal, korrutades rastri ühe piksli pindalaga ning seejärel summeerides saadud rastri kõigi pikslite väärtused. Apollo madala puhul kasutati 20 m sügausjoone järgi tekitatud maski mis koosnes 99 pikslist ning mille pindala oli seega  $99 \times 500^2$  ruutmeetrit e  $24.75 \text{ km}^2$ . Kogu mereala puhul kasutati maski, mille pindala koosnes 6874 pikslist, kogupindalaga  $1718.5 \text{ km}^2$

## Tulemused

Tihedusmudelit ei leitud liikidele, mille puhul oli valimis alla 10 parve vaatluse. Modelleerimise tulemused võtab kokku alljärgnev tabel. Detailid iga liigi mudelite kohta leiab lisast.

Tabel 1: Asustustiheduste mudeldamise kokkuvõte.

season	kood	species	ddf.formula	ddf.df	ddf.AIC	dsm.formula	dsm.AIC
1	kevad	all	~1	hr	54.50	D ~ s(cx, cy) + s(depth05, k = 4)	29394.60
2	kevad	tiirud	~sun	hr	123.80	D ~ s(cx, cy)	6831.70
3	kevad	sukelpart	~obs	hr	408.00	D ~ s(cx, cy) + s(depth05, k = 4)	51971.50
4	kevad	vaerad	~1	hr	63.90	D ~ s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)	32726.70
5	kevad	kaurid	~1	hr	18.50	D ~ s(cx, cy)	8829.00
6	kevad	255	~1	hr	22.40	D ~ s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)	5839.30
7	kevad	95	~1	hr	177.80	D ~ s(cx, cy)	47209.30
8	kevad	93	~1	hr	137.50	D ~ s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)	47544.70
9	kevad	90	~1	hn	16.90	D ~ s(cx, cy)	3112.70
10	suvi	all	~obs	hr	348.80	D ~ s(cx, cy) + s(coast05, k = 4)	6660.20
11	suvi	kajakad	~obs	hr	348.80	D ~ s(cx, cy) + s(coast05, k = 4)	6660.20
12	suvi	tiirud	~1	hr	136.90	D ~ s(cx, cy)	5676.50
13	suvi	vaerad	~obs + wav	hn	231.30	D ~ s(cx, cy)	29636.00
14	suvi	286	~1	hn	12.40	D ~ s(cx, cy) + s(coast05, k = 4)	3250.90
15	suvi	95	~size	hr	337.70	D ~ s(cx, cy) + s(depth05, k = 4)	36781.40
16	sygis	all	~obs + wav	hn	240.70	D ~ s(cx, cy)	16923.40
17	sygis	sukelpart	~wav	hn	101.80	D ~ s(cx, cy) + s(depth05, k = 4)	9271.50
18	sygis	256	~wav	hr	128.20	D ~ s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)	11578.50
19	sygis	255	~obs + wav	hn	240.70	D ~ s(cx, cy)	16923.40
20	sygis	93	~obs + wav	hn	85.30	D ~ s(cx, cy)	30458.30
21	talv	all	~obs + wav	hn	85.30	D ~ s(cx, cy)	30458.30
22	talv	sukelpart	~sun	hr	545.90	D ~ s(cx, cy) + s(depth05, k = 4)	45913.50
23	talv	vaerad	~sun	hr	27.50	D ~ s(cx, cy) + s(depth05, k = 4)	3292.80
24	talv	kaurid	~size	hn	65.40	D ~ s(cx, cy) + s(coast05, k = 4)	5794.40
25	talv	256	~sun	hr	167.10	D ~ s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)	23017.70
26	talv	255	~size	hr	372.10	D ~ s(cx, cy) + s(ship05, k = 4)	48056.80
27	talv	93	~sun	hr	413.50	D ~ s(cx, cy) + s(depth05, k = 4)	49914.30
28	talv	90	~1	hr	54.50	D ~ s(cx, cy) + s(depth05, k = 4)	29394.60

# Kirjandus

- [HB04] Sharon Hedley and Stephen Buckland. Spatial Models for Line Transect Sampling. *Journal of Agricultural, Biological, and Environmental Statistics*, 9:181–199, 2004.
- [MRB<sup>+</sup>14] David L. Miller, Eric Rexstad, Louise Burt, Mark V. Bravington, and Sharon Hedley. *dsm: Density surface modelling of distance sampling data*, 2014. R package version 2.2.5.
- [R C14] R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2014.

**Lisa A**

**Analüüsiväljundid**









14940	kevad	283	5660	1	163	2217	HP/TK	1	2	3	570000	6565489
14994	kevad	93	57541	15	163	1776	LL	1	1	3	566959	6560996
14997	kevad	93	57571	20	432	1776	LL	1	1	3	566960	6560739
15000	kevad	283	57601	15	163	1775	LL	1	1	3	566955	6560476
15003	kevad	283	57631	4	432	1775	LL	1	1	3	566954	6560205
15020	kevad	283	57801	10	1000	1772	HP/TK	1	2	2	566960	6558595
15062	kevad	90	58221	2	163	1764	HP/TK	1	2	2	566962	6554886
15117	kevad	283	58771	1	163	1755	LL	1	1	3	566952	6550148
15164	kevad	283	59241	1	1000	1746	HP/TK	1	2	2	566965	6545977
15243	kevad	90	60031	2	163	1733	LL	1	1	3	566982	6539212
15311	kevad	93	61271	180	432	1303	LL	1	0	3	563988	6540171
15314	kevad	93	61301	45	432	1303	LL	1	0	3	563988	6540428
15341	kevad	95	61571	1	432	1308	LL	1	0	3	564005	6542767
15344	kevad	93	61601	4	163	1309	LL	1	0	3	564006	6543030
15356	kevad	93	61721	65	163	1311	LL	1	0	3	564011	6544077
15362	kevad	95	61781	1	163	1312	LL	1	0	3	563997	6544601
15374	kevad	283	61901	1	163	1314	LL	1	0	3	563983	6545641
15400	kevad	269	62161	1	1000	1319	HP/TK	1	2	2	563994	6548004
15404	kevad	93	62201	2	163	1319	LL	1	0	3	563992	6548263
15420	kevad	255	62361	1	432	1322	HP/TK	1	0	3	564010	6549563
15427	kevad	283	62431	1	432	1323	HP/TK	1	2	2	564009	6550334
15432	kevad	90	62481	1	163	1324	HP/TK	1	0	3	564011	6550592
15436	kevad	90	62521	1	432	1325	HP/TK	1	2	2	564006	6551111
15442	kevad	90	62581	2	432	1326	HP/TK	1	2	2	564002	6551630
15476	kevad	105	62921	2	432	1331	LL	1	0	3	563994	6554436
15504	kevad	255	63201	1	432	1336	HP/TK	1	0	3	564004	6556770
15511	kevad	283	63271	1	432	1338	HP/TK	1	2	2	563996	6557541
15545	kevad	255	63971	2	432	902	HP/TK	1	1	3	560986	6555980
15604	kevad	283	6456	1	432	892	LL	1	1	3	560960	6550746
15607	kevad	283	6459	1	432	891	LL	1	1	3	560957	6550489
15609	kevad	283	64611	3	432	891	HP/TK	1	2	2	560965	6550233
15613	kevad	283	6465	1	432	890	LL	1	1	3	560969	6549978
15616	kevad	283	6468	7	432	890	LL	1	1	3	560959	6549723
15630	kevad	283	6482	1	1000	887	HP/TK	1	2	2	560980	6548397
15646	kevad	283	6498	1	163	885	LL	1	1	3	560984	6547078
15650	kevad	255	6502	3	432	884	HP/TK	1	1	3	560990	6546817
15761	kevad	95	66131	60	1000	865	HP/TK	1	1	3	560990	6537156
15771	kevad	95	66611	80	163	434	LL	1	0	3	557975	6537644
15774	kevad	95	66641	260	432	434	LL	1	0	3	557973	6537903
15776	kevad	99	66661	1	432	435	HP/TK	1	1	2	557986	6538162
15777	kevad	95	66671	140	1000	435	LL	1	0	3	557986	6538162
15780	kevad	95	66701	30	163	435	LL	1	0	3	557991	6538421
15786	kevad	93	66761	4	432	436	LL	1	0	3	557992	6538939
15817	kevad	255	67071	1	163	441	HP/TK	1	0	3	557982	6541485
15837	kevad	283	67271	1	432	445	LL	1	0	3	557987	6543282
15838	kevad	283	67281	1	163	445	HP/TK	1	0	3	557987	6543282
15929	kevad	283	68191	2	1000	461	HP/TK	1	2	2	557964	6551280
15994	kevad	283	6884	1	432	472	HP/TK	1	0	3	557955	6556623
15998	kevad	283	6888	1	432	473	HP/TK	1	2	2	557957	6557129
16085	kevad	283	70191	1	432	25	LL	1	0	3	554938	6549249
16100	kevad	90	70341	3	432	22	LL	1	0	3	554940	6547941
16116	kevad	255	70501	3	432	20	HP/TK	1	1	3	554966	6546655
16117	kevad	255	70512	1	432	19	HP/TK	1	2	2	554960	6546391
16120	kevad	283	70541	1	432	19	HP/TK	1	2	2	554951	6546126
16121	kevad	1	70551	1	432	19	LL	1	0	3	554951	6546126
16123	kevad	283	70571	4	432	18	HP/TK	1	2	2	554941	6545864
16125	kevad	255	70591	4	432	18	HP/TK	1	1	3	554941	6545864
16163	kevad	283	70971	1	163	12	LL	1	0	3	554984	6542503
16208	kevad	95	71421	2	163	4	LL	1	0	3	554967	6538651
16211	kevad	95	71451	14	432	3	LL	1	0	3	554970	6538390
16214	kevad	95	71481	3	1000	3	LL	1	0	3	554967	6538123

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{cde}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object

Number of observations : 37  
Distance range : 0 - 1500  
AIC : 54.54388

Detection function:

Hazard-rate key function

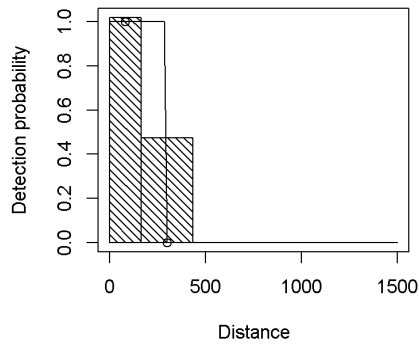
Detection function parameters

Scale Coefficients:  
estimate se  
(Intercept) 5.685627 0.12486

Shape parameters:

estimate se  
(Intercept) 11.29716 230.0597

	Estimate	SE	CV
Average p	0.1964036	0.0245225	0.1248577
N in covered region	188.3876115	36.3877241	0.1931535



Joonis A.1: Avastamisfunktsioon: kevad – kõik liigid.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

**Mudeli koond:**

Family: quasipoisson

Link function: log

Formula:

$D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-77.3810	0.3534	-218.9	<2e-16 ***

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

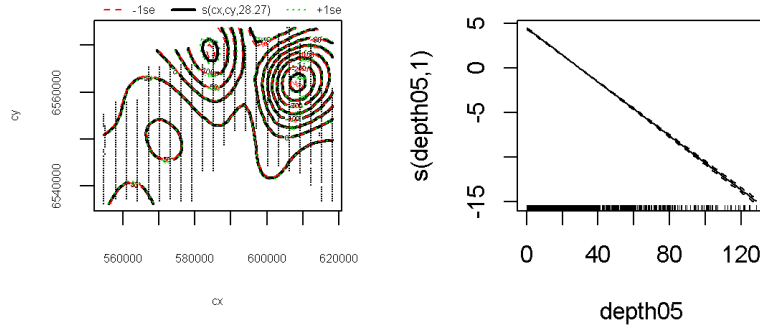
	edf	Ref.df	F	p-value
s(cx,cy)	28.27	28.74	9782	<2e-16 ***
s(depth05)	1.00	1.00	10421	<2e-16 ***

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.696 Deviance explained = 81.1%

GCV = 5.4557 Scale est. = 0.019894 n = 1106



Joonis A.2: Tiheduspinna tunnused: kevad – kõik liigid.

## Tiirud Andmetabel

Tabel A.2: Andmetabel: kevad – tiirud.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
10242	kevad	283	25212	1	163	9116	HP/TK	1	0	3	617942	6558540
10256	kevad	283	26612	1	432	9118	HP/TK	1	0	3	617949	6559852
10277	kevad	283	32910	1	432	8687	HP/TK	1	1	3	615061	6560294
10554	kevad	283	67410	1	163	8216	HP/TK	1	0	3	611978	6540796
10577	kevad	283	69711	1	163	8220	LL	1	0	3	611979	6542823
10580	kevad	283	70011	1	163	8221	LL	1	0	3	611976	6543081
10581	kevad	283	70111	2	163	8221	HP/TK	1	0	3	611976	6543081
10610	kevad	283	7302	1	163	8226	LL	1	0	3	611985	6545687
10614	kevad	283	73411	1	163	8226	HP/TK	1	0	3	611983	6545946
10625	kevad	283	74511	1	432	8228	LL	1	0	3	611982	6546981
10734	kevad	283	8542	1	163	8247	HP/TK	1	0	3	611978	6556475
11005	kevad	283	11652	1	163	7822	LL	1	0	3	608970	6559843
11006	kevad	283	11662	1	163	7822	HP/TK	1	0	3	608970	6559843
11065	kevad	283	12252	1	163	7812	LL	1	0	3	608973	6554561
11158	kevad	283	13182	1	163	7795	LL	1	0	3	608980	6546472
11166	kevad	283	13262	1	163	7794	HP/TK	1	1	3	608973	6545945
11274	kevad	283	14761	1	163	7369	LL	1	0	3	606024	6549393
11277	kevad	283	14791	1	432	7370	LL	1	0	3	606026	6549647
11281	kevad	283	14831	1	163	7370	HP/TK	1	0	3	606022	6549904
11524	kevad	283	17262	1	432	7413	HP/TK	1	0	3	606020	6571004
11526	kevad	283	17282	1	163	7413	LL	1	0	3	606016	6571323
11544	kevad	283	17462	1	163	7416	LL	1	0	3	605997	6572909
11699	kevad	283	19372	1	432	6958	LL	1	0	3	602967	6559672
11703	kevad	283	19413	1	432	6957	HP/TK	1	0	3	602965	6559409
11745	kevad	283	19832	1	163	6950	HP/TK	1	0	3	602972	6555735
11777	kevad	283	20152	1	163	6944	LL	1	0	3	602982	6552977
11888	kevad	283	21682	1	432	6497	HP/TK	1	0	3	599937	6545218
12327	kevad	283	26552	1	163	6089	LL	1	0	3	596966	6557069
12348	kevad	283	26762	1	163	6085	LL	1	0	3	597005	6555234
12367	kevad	283	26951	1	432	6082	HP/TK	1	0	3	596996	6553663
12377	kevad	283	27051	1	163	6080	HP/TK	1	1	3	597018	6552871
12631	kevad	283	3043	1	163	5245	LL	1	1	3	591014	6567008
12638	kevad	283	3050	1	163	5243	HP/TK	1	0	3	591018	6566477
12650	kevad	283	3062	3	432	5241	HP/TK	1	0	3	591004	6565424
12798	kevad	283	32103	2	432	5216	HP/TK	1	2	3	590949	6552668
13241	kevad	283	37551	1	432	4353	HP/TK	1	2	2	584939	6553466
13261	kevad	283	37751	1	163	4350	HP/TK	1	1	3	584940	6551899
13262	kevad	283	37761	1	163	4350	HP/TK	1	2	2	584943	6551634
13333	kevad	283	38471	1	163	4338	HP/TK	1	0	3	584956	6545551
13341	kevad	283	38551	1	163	4336	LL	1	0	3	584958	6544753
13371	kevad	283	39312	1	432	3902	HP/TK	1	0	3	581960	6543584
13439	kevad	283	39991	1	432	3913	LL	1	0	3	581993	6549442
13662	kevad	283	42601	1	163	3507	HP/TK	1	2	2	578970	6562007
13808	kevad	283	44061	1	432	3481	HP/TK	1	1	3	578980	6549464
13812	kevad	283	44101	1	432	3480	HP/TK	1	2	2	578987	6548937
13925	kevad	283	45231	1	163	3461	HP/TK	1	1	2	578957	6539300
13927	kevad	283	45251	1	163	3461	LL	1	0	2	578953	6539040
14238	kevad	283	48801	1	432	3074	LL	1	0	2	575983	6561589
14244	kevad	283	48861	1	163	3075	LL	1	0	2	575980	6562107
14247	kevad	283	48891	2	432	3075	LL	1	0	2	575981	6562370
14253	kevad	283	48951	1	432	3076	LL	1	0	2	575980	6562899
14271	kevad	283	49131	1	163	3079	LL	1	0	2	575964	6564479
14342	kevad	283	50221	1	163	2640	LL	1	1	3	572947	6560515
14875	kevad	283	5595	1	163	2206	LL	1	0	3	570005	6559707
14940	kevad	283	5660	1	163	2217	HP/TK	1	2	3	570000	6565489
15000	kevad	283	57601	15	163	1775	LL	1	1	3	566955	6560476
15003	kevad	283	57631	4	432	1775	LL	1	1	3	566954	6560205
15020	kevad	283	57801	10	1000	1772	HP/TK	1	2	2	566960	6558595
15117	kevad	283	58771	1	163	1755	LL	1	1	3	566952	6550148
15164	kevad	283	59241	1	1000	1746	HP/TK	1	2	2	566965	6545977
15374	kevad	283	61901	1	163	1314	LL	1	0	3	563983	6545641
15427	kevad	283	62431	1	432	1323	HP/TK	1	2	2	564009	6550334

15511	kevad	283	63271	1	432	1338	HP/TK	1	2	2	563996	6557541
15604	kevad	283	6456	1	432	892	LL	1	1	3	560960	6550746
15607	kevad	283	6459	1	432	891	LL	1	1	3	560957	6550489
15609	kevad	283	64611	3	432	891	HP/TK	1	2	2	560965	6550233
15613	kevad	283	6465	1	432	890	LL	1	1	3	560969	6549978
15616	kevad	283	6468	7	432	890	LL	1	1	3	560959	6549723
15630	kevad	283	6482	1	1000	887	HP/TK	1	2	2	560980	6548397
15646	kevad	283	6498	1	163	885	LL	1	1	3	560984	6547078
15837	kevad	283	67271	1	432	445	LL	1	0	3	557987	6543282
15838	kevad	283	67281	1	163	445	HP/TK	1	0	3	557987	6543282
15929	kevad	283	68191	2	1000	461	HP/TK	1	2	2	557964	6551280
15994	kevad	283	6884	1	432	472	HP/TK	1	0	3	557955	6556623
15998	kevad	283	6888	1	432	473	HP/TK	1	2	2	557957	6557129
16085	kevad	283	70191	1	432	25	LL	1	0	3	554938	6549249
16120	kevad	283	70541	1	432	19	HP/TK	1	2	2	554951	6546126
16123	kevad	283	70571	4	432	18	HP/TK	1	2	2	554941	6545864
16163	kevad	283	70971	1	163	12	LL	1	0	3	554984	6542503

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{mcds}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{sun})$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object

Number of observations : 79  
Distance range : 0 - 1500  
AIC : 123.8109

Detection function:

Hazard-rate key function

Detection function parameters

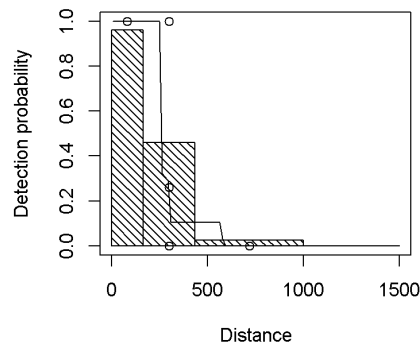
Scale Coefficients:

	estimate	se
(Intercept)	5.5341441	1.8844783
sun1	0.1532461	0.5365571
sun2	0.8155729	0.2603057

Shape parameters:

	estimate	se
(Intercept)	4.658107	311.701

	Estimate	SE	CV
Average p	0.1977565	0.01840056	0.09304656
N in covered region	399.4812687	55.17820948	0.13812465



Joonis A.3: Avastamisfunktsioon: kevad – tiirud.

## Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy)$   
Mudeli koond:

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy)$

Parametric coefficients:

```
Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.560e+01 1.899e-04 -82119 <2e-16 ***
---
```

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

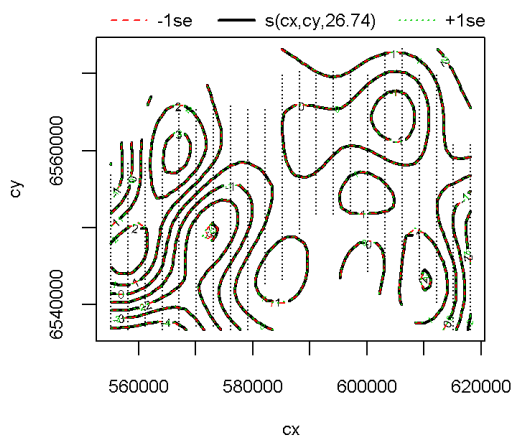
Approximate significance of smooth terms:

```
edf Ref.df F p-value
s(cx,cy) 26.74 28.63 4944821 <2e-16 ***
---
```

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.0612 Deviance explained = 24.5%

GCV = 3.1102 Scale est. = 6.2116e-06 n = 1099



Joonis A.4: Tiheduspinna tunnused: kevad – tiirud.

## Sukelpardid

### Andmetabel

Tabel A.3: Andmetabel: kevad – sukelpardid.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
10057	kevad	95	67101	2	1000	9084	LL	1	0	3		617982	6542623
10070	kevad	95	8012	3	432	9086	HP/TK	1	0	3		617980	6543654
10087	kevad	95	9712	1	1500	9089	LL	1	0	3		617985	6545195
10162	kevad	98	17212	4	432	9102	LL	1	0	3		617960	6551801
10165	kevad	98	17512	8	163	9103	LL	1	0	3		617955	6552061
10166	kevad	95	17612	1	163	9103	HP/TK	1	0	3		617955	6552061
10313	kevad	98	36510	12	432	8681	HP/TK	1	1	3		614986	6557142
10399	kevad	95	45110	6	163	8665	HP/TK	1	0	3		614969	6549465
10404	kevad	95	45611	4	163	8664	LL	1	1	3		614972	6548942
10407	kevad	95	45911	3	163	8664	LL	1	1	3		614977	6548689







**Valitud avastamisfunktsioon:** hazard-rate key function  
**Mudeli koond:**

Summary for ds object  
 Number of observations : 215  
 Distance range : 0 - 1500  
 AIC : 407.9501

Detection function:  
 Hazard-rate key function

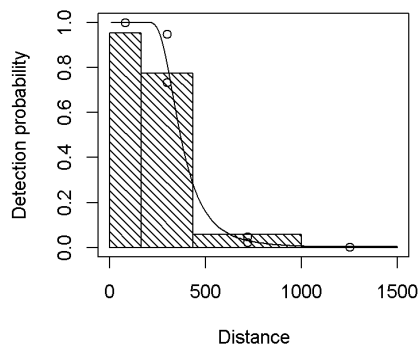
Detection function parameters  
 Scale Coefficients:  

	estimate	se
(Intercept)	5.9312639	0.1162991
obsLL	-0.1721669	0.1204076

Shape parameters:  

	estimate	se
(Intercept)	1.538844	0.1697998

	Estimate	SE	CV
Average p	0.2668611	0.01988768	0.07452445
N in covered region	805.6624944	76.31592174	0.09472443



Joonis A.5: Avastamisfunktsioon: kevad – sukelpardid.

**Tiheduspind**

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Parametric coefficients:  

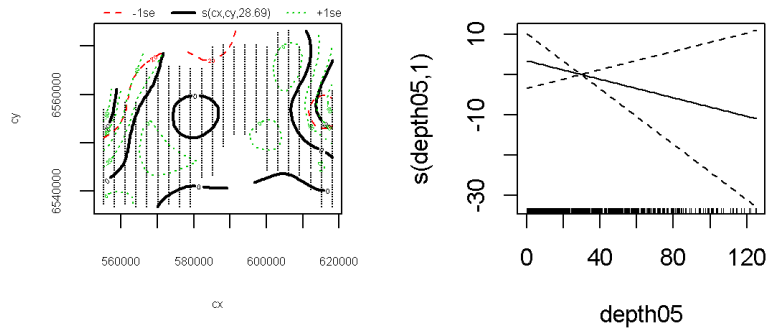
	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-15.855	3.314	-4.785	1.95e-06 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	28.69	28.98	0.377	0.999
s(depth05)	1.00	1.00	1.005	0.316

R-sq.(adj) = 0.146    Deviance explained = 45%  
 GCV = 135.07    Scale est. = 4370.4    n = 1097



Joonis A.6: Tiheduspinna tunnused: kevad – sukelpardid.

## Vaerad

### Andmetabel

Tabel A.4: Andmetabel: kevad – vaerad.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
10162	kevad	98	17212	4	432	9102	LL	1	0	3	617960	6551801
10165	kevad	98	17512	8	163	9103	LL	1	0	3	617955	6552061
10313	kevad	98	36510	12	432	8681	HP/TK	1	1	3	614986	6557142
10490	kevad	98	54211	6	432	8650	HP/TK	1	1	3	614968	6541562
10633	kevad	98	75311	4	163	8230	HP/TK	1	1	3	611978	6547506
10664	kevad	98	78411	20	432	8235	LL	1	0	3	611978	6550423
10667	kevad	98	78711	4	163	8236	LL	1	0	3	611974	6550687
11050	kevad	98	12103	2	432	7814	LL	1	0	3	608969	6555869
11448	kevad	99	16502	2	432	7399	LL	1	0	3	605999	6564486
11451	kevad	98	16532	4	163	7400	LL	1	0	3	605995	6564739
11606	kevad	98	18442	30	432	6974	LL	1	1	3	602996	6567856
11609	kevad	98	18472	20	163	6974	LL	1	1	3	602992	6567593
11762	kevad	99	20002	2	163	6947	LL	1	0	3	602981	6554216
11798	kevad	99	20362	24	432	6941	LL	1	0	3	602978	6551189
11801	kevad	99	20392	24	163	6940	LL	1	0	3	602987	6550928
11810	kevad	99	20482	45	163	6939	LL	1	0	3	602979	6550158
11813	kevad	99	20513	24	432	6938	LL	1	0	3	602990	6549903
11816	kevad	99	20542	28	163	6938	LL	1	0	3	602995	6549652
11819	kevad	99	20572	8	432	6937	LL	1	0	3	602996	6549396
11891	kevad	98	21713	3	432	6497	HP/TK	1	0	3	599938	6545469
11895	kevad	98	21752	4	432	6498	HP/TK	1	1	3	599941	6545722
11984	kevad	99	22642	1	163	6513	HP/TK	1	0	3	599975	6553292
12070	kevad	98	23501	20	163	6528	LL	1	0	3	600003	6560882
12127	kevad	98	24072	12	432	6538	LL	1	0	3	599990	6565708
12964	kevad	98	34401	23	163	4804	LL	1	1	3	588010	6562655
12967	kevad	98	34431	14	432	4804	LL	1	1	3	588016	6562917
13338	kevad	99	38521	1	163	4337	LL	1	0	3	584964	6545021
13412	kevad	98	39721	1	432	3909	LL	1	0	3	581986	6547135
13669	kevad	98	42671	1	432	3505	LL	1	0	3	578970	6561472
13716	kevad	99	43141	1	432	3497	HP/TK	1	2	2	578959	6557223
13719	kevad	98	43171	5	432	3496	HP/TK	1	2	2	578945	6556959
13807	kevad	98	44051	8	163	3481	LL	1	0	3	578980	6549464
14226	kevad	98	48681	2	163	3072	LL	1	0	2	575973	6560537
14229	kevad	98	48712	4	432	3072	LL	1	0	2	575977	6560803
14354	kevad	98	50341	3	163	2637	LL	1	1	3	572939	6559469
14592	kevad	98	52721	1	432	2596	HP/TK	1	0	3	572986	6538868
14653	kevad	98	53731	15	1000	2167	LL	1	0	3	570012	6540411
15776	kevad	99	66661	1	432	435	HP/TK	1	1	2	557986	6538162

### Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{cde}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

Valitud avastamisfunktsioon: hazard-rate key function

## Mudeli koond:

Summary for ds object

Number of observations : 38  
Distance range : 0 - 1500  
AIC : 63.86632

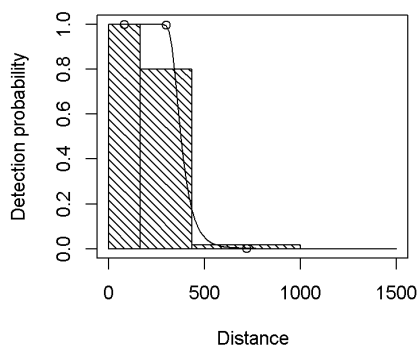
Detection function:  
Hazard-rate key function

Detection function parameters

Scale Coefficients:  
estimate se  
(Intercept) 5.890821 0.2485416

Shape parameters:  
estimate se  
(Intercept) 2.199698 0.8089232

	Estimate	SE	CV
Average p	0.2598292	0.04941905	0.1901982
N in covered region	146.2498954	34.50181202	0.2359100



Joonis A.7: Avastamisfunktsioon: kevad – vaerad.

## Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{depth}05, k = 4) + s(\text{coast}05, k = 4)$

**Mudeli koond:**

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{depth}05, k = 4) + s(\text{coast}05, k = 4)$

Parametric coefficients:  
Estimate Std. Error t value Pr(>|t|)  
(Intercept) -47.7069 0.5645 -84.51 <2e-16 \*\*\*

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

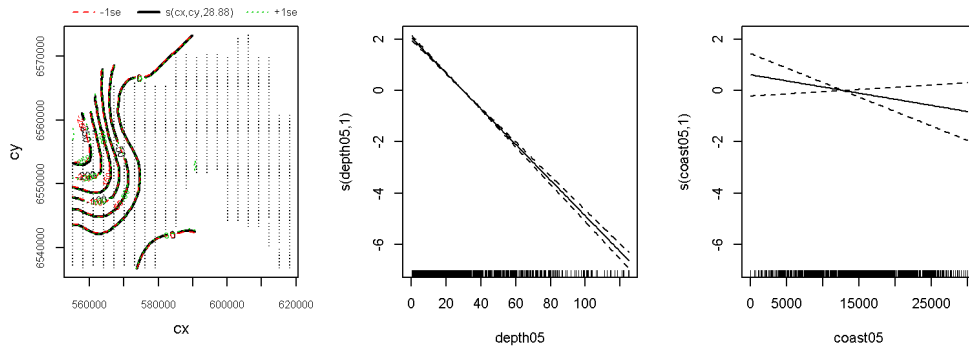
Approximate significance of smooth terms:  
edf Ref.df F p-value

```

s(cx,cy) 28.88 28.99 1317.890 <2e-16 ***
s(depth05) 1.00 1.00 1826.721 <2e-16 ***
s(coast05) 1.00 1.00 2.157 0.142
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.364 Deviance explained = 51.7%
GCV = 5.8919 Scale est. = 0.074501 n = 1097

```



Joonis A.8: Tiheduspinna tunnused: kevad – vaerad.

## Kaurid

### Andmetabel

Tabel A.5: Andmetabel: kevad – kaurid.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
10095	kevad	1	10512	1	432	9090	HP/TK	1	0	3	617985	6545712
10128	kevad	1	13812	1	432	9096	HP/TK	1	0	3	617949	6548592
10485	kevad	1	53711	1	432	8650	LL	1	1	3	614963	6541826
10488	kevad	1	54011	2	432	8650	LL	1	1	3	614968	6541562
10491	kevad	1	54311	1	163	8649	LL	1	1	3	614971	6541298
10790	kevad	1	9103	1	163	8257	LL	1	0	3	611978	6561469
10793	kevad	1	9132	2	432	8258	LL	1	0	3	611978	6561731
12910	kevad	1	33861	1	432	4794	LL	1	1	3	588048	6557959
14100	kevad	1	47421	2	432	3049	LL	1	0	3	575999	6549460
14112	kevad	1	47541	1	163	3052	LL	1	0	3	575997	6550505
14232	kevad	1	48741	1	432	3073	LL	1	0	2	575981	6561065
16121	kevad	1	70551	1	432	19	LL	1	0	3	554951	6546126

### Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{cds}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

Valitud avastamisfunktsioon: hazard-rate key function

Mudeli koond:

```

Summary for ds object
Number of observations : 12
Distance range       : 0 - 1500
AIC                  : 18.52767

```

Detection function:  
Hazard-rate key function

Detection function parameters

```

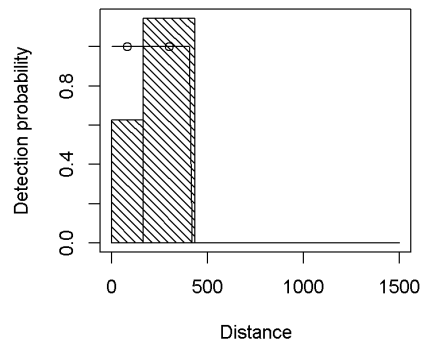
Scale Coefficients:
      estimate      se
(Intercept) 6.016421 75467.08

```

Shape parameters:

	estimate	se
(Intercept)	5.452952	30463276

	Estimate	SE	CV
Average p	0.2740885	211.2482	770.7299
N in covered region	43.7814837	33743.6981	770.7299



Joonis A.9: Avastamisfunktsioon: kevad – kaurid.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy)$   
**Mudeli koond:**

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-1.749e+01	3.185e-04	-54923	<2e-16 ***

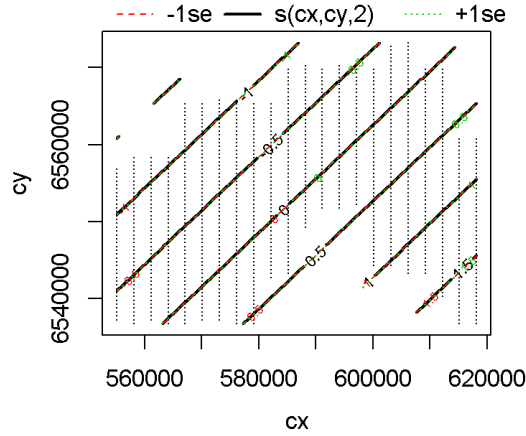
---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	2	2	4423102	<2e-16 ***

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.00663 Deviance explained = 6.1%  
GCV = 0.44277 Scale est. = 3.6229e-06 n = 1099



Joonis A.10: Tiheduspinna tunnused: kevad – kaurid.

## Kalakajakas *Larus canus*

### Andmetabel

Tabel A.6: Andmetabel: kevad – kalakajakas.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
10047	kevad	255	57101	1	432	9082	HP/TK	1	0	3		617975	6541599
10207	kevad	255	21712	1	432	9110	LL	1	0	3		617952	6555656
10602	kevad	255	72210	1	432	8224	HP/TK	1	0	3		611977	6544914
10982	kevad	255	11422	1	163	7826	HP/TK	1	0	3		608970	6561963
11296	kevad	255	14981	1	432	7373	HP/TK	1	0	3		606015	6551205
13349	kevad	255	38631	1	163	4334	HP/TK	1	2	2		584994	6543931
14936	kevad	255	5656	1	163	2216	HP/TK	1	0	3		570014	6564966
15420	kevad	255	62361	1	432	1322	HP/TK	1	0	3		564010	6549563
15504	kevad	255	63201	1	432	1336	HP/TK	1	0	3		564004	6556770
15545	kevad	255	63971	2	432	902	HP/TK	1	1	3		560986	6555980
15650	kevad	255	6502	3	432	884	HP/TK	1	1	3		560990	6546817
15817	kevad	255	67071	1	163	441	HP/TK	1	0	3		557982	6541485
16116	kevad	255	70501	3	432	20	HP/TK	1	1	3		554966	6546655
16117	kevad	255	70512	1	432	19	HP/TK	1	2	2		554960	6546391
16125	kevad	255	70591	4	432	18	HP/TK	1	1	3		554941	6545864

### Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{cds}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

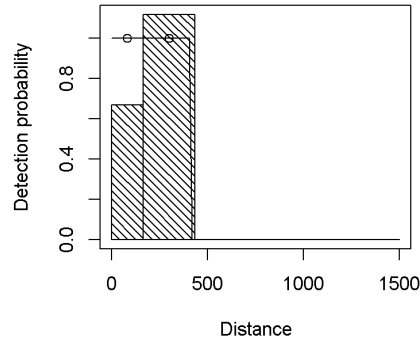
```
Summary for ds object
Number of observations : 15
Distance range       : 0 - 1500
AIC                  : 22.36773
```

```
Detection function:
Hazard-rate key function
```

```
Detection function parameters
Scale Coefficients:
      estimate      se
(Intercept) 6.013585 0.09201636
```

```
Shape parameters:
      estimate      se
(Intercept) 5.474302 7.824824
```

	Estimate	SE	CV
Average p	0.2732979	0.02509683	0.0918296
N in covered region	54.8851718	13.08979534	0.2384942



Joonis A.11: Avastamisfunktsioon: kevad – kalakajakas *Larus canus*.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-179.92812	0.02837	-6342	<2e-16 ***

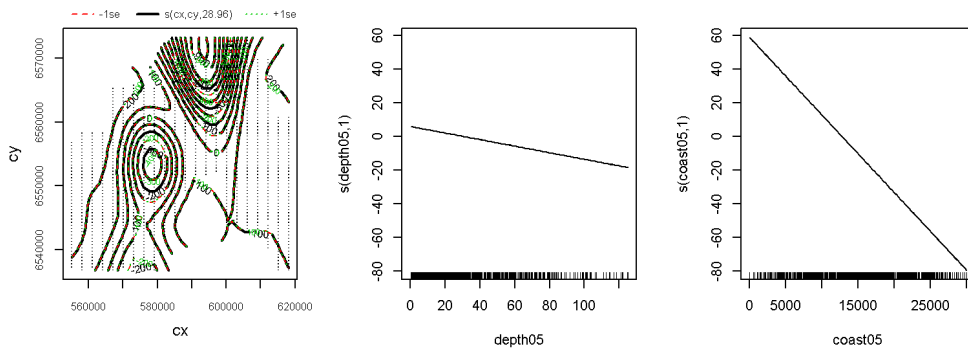
---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	28.96	29	6536685	<2e-16 ***
s(depth05)	1.00	1	64474062	<2e-16 ***
s(coast05)	1.00	1	8715076	<2e-16 ***

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.318    Deviance explained = 60.4%  
GCV = 0.29411    Scale est. = 7.5e-07    n = 1097



Joonis A.12: Tiheduspinna tunnused: kevad – kalakajakas *Larus canus*.

## Hahk *Somateria mollissima*

### Andmetabel

Tabel A.7: Andmetabel: kevad – hahk.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
10057	kevad	95	67101	2	1000	9084	LL	1	0	3	617982	6542623
10070	kevad	95	8012	3	432	9086	HP/TK	1	0	3	617980	6543654
10087	kevad	95	9712	1	1500	9089	LL	1	0	3	617985	6545195
10166	kevad	95	17612	1	163	9103	HP/TK	1	0	3	617955	6552061
10399	kevad	95	45110	6	163	8665	HP/TK	1	0	3	614969	6549465
10404	kevad	95	45611	4	163	8664	LL	1	1	3	614972	6548942
10407	kevad	95	45911	3	163	8664	LL	1	1	3	614977	6548689
10416	kevad	95	46811	1	163	8662	LL	1	1	3	614960	6547907
10419	kevad	95	47111	3	432	8662	LL	1	1	3	614962	6547641
10452	kevad	95	50411	65	163	8656	LL	1	1	3	614969	6544730
10457	kevad	95	50911	6	432	8655	HP/TK	1	1	3	614973	6544470
10463	kevad	95	51511	60	432	8654	HP/TK	1	1	3	614969	6543941
10464	kevad	95	51610	80	163	8654	LL	1	1	3	614967	6543667
10465	kevad	95	51710	40	432	8654	HP/TK	1	0	3	614967	6543667
10467	kevad	95	51910	45	432	8653	LL	1	1	3	614967	6543401
10468	kevad	95	52010	60	163	8653	HP/TK	1	0	3	614967	6543401
10472	kevad	95	52411	40	432	8653	HP/TK	1	1	3	614968	6543140
10475	kevad	95	52711	50	163	8652	HP/TK	1	1	3	614969	6542878
10601	kevad	95	72111	2	432	8224	LL	1	0	3	611977	6544914
10604	kevad	95	7242	2	432	8225	LL	1	0	3	611980	6545173
10605	kevad	95	7252	7	432	8225	HP/TK	1	0	3	611980	6545173
10609	kevad	95	7292	1	432	8225	HP/TK	1	1	3	611981	6545431
10615	kevad	95	73511	200	432	8226	HP/TK	1	1	3	611983	6545946
10617	kevad	95	73711	1	163	8227	HP/TK	1	0	3	611973	6546203
10619	kevad	95	73911	3	432	8227	LL	1	0	3	611967	6546461
11152	kevad	95	13122	8	163	7796	LL	1	0	3	608966	6546993
11155	kevad	95	13152	12	432	7796	LL	1	0	3	608978	6546732
11164	kevad	95	13242	12	432	7794	LL	1	0	3	608973	6545945
11167	kevad	95	13272	23	163	7794	LL	1	0	3	608975	6545678
11224	kevad	95	14262	3	163	7361	HP/TK	1	0	3	606020	6545020
11225	kevad	95	14272	1	163	7361	HP/TK	1	1	3	606020	6545020
11231	kevad	95	14332	1	432	7362	HP/TK	1	1	3	606022	6545533
11232	kevad	95	14342	2	163	7362	LL	1	0	3	606020	6545791
11236	kevad	95	14382	3	432	7363	HP/TK	1	0	3	606021	6546046
11245	kevad	95	14472	1	432	7364	HP/TK	1	0	3	606019	6546831
11547	kevad	95	17492	2	163	9825	LL	1	0	3	605992	6573169
11735	kevad	95	19732	8	163	6952	LL	1	0	3	602971	6556517
11795	kevad	95	20332	230	163	6941	LL	1	0	3	602973	6551449
11799	kevad	95	20372	14	432	6941	HP/TK	1	0	3	602978	6551189
11827	kevad	95	20652	80	432	6936	HP/TK	1	1	3	602995	6548876
11846	kevad	95	20842	180	163	6933	LL	1	0	3	603008	6547043
11848	kevad	95	20862	2	432	6933	HP/TK	1	1	3	603008	6547043
11906	kevad	95	21862	7	163	6500	HP/TK	1	0	3	599955	6546743
11919	kevad	95	21992	1	432	6502	HP/TK	1	1	3	599965	6547753
11925	kevad	95	22052	1	163	6503	HP/TK	1	1	3	599962	6548245
11938	kevad	95	22182	2	163	6505	LL	1	0	3	599970	6549497
11957	kevad	95	22372	7	432	6509	HP/TK	1	0	3	599985	6551007
11961	kevad	95	22413	7	432	6509	HP/TK	1	1	3	599987	6551258
11965	kevad	95	22452	4	432	6510	LL	1	0	3	599970	6551765
11967	kevad	95	22472	100	432	6510	HP/TK	1	0	3	599970	6551765
11972	kevad	95	22522	1	163	6511	HP/TK	1	1	3	599969	6552277
11974	kevad	95	22542	18	432	6512	LL	1	0	3	599976	6552528
11976	kevad	95	22562	1	163	6512	HP/TK	1	1	3	599976	6552528
11985	kevad	95	22652	2	432	6513	HP/TK	1	1	3	599975	6553292
13332	kevad	95	38461	1	163	4338	LL	1	0	3	584956	6545551
13906	kevad	95	4504	4	163	3464	LL	1	0	2	578957	6540882
13909	kevad	95	4507	2	432	3464	LL	1	0	2	578957	6540610
13930	kevad	95	45281	2	163	3460	LL	1	0	2	578951	6538780
13945	kevad	95	45431	8	163	3457	LL	1	0	2	578968	6537490
13998	kevad	95	46401	15	432	3032	LL	1	0	3	575976	6540688
14007	kevad	95	46491	3	432	3033	LL	1	0	3	575989	6541443
14027	kevad	95	46691	10	1000	3037	HP/TK	1	1	3	575976	6543228
14052	kevad	95	46941	7	163	3041	LL	1	0	3	575989	6545320
14054	kevad	95	46961	6	432	3042	HP/TK	1	1	3	575988	6545569
14064	kevad	95	47061	1	432	3043	LL	1	0	3	575986	6546333



14080	kevad	95	47221	3	432	3046	HP/TK	1	0	3	575983	6547619
14083	kevad	95	47251	1	432	3046	HP/TK	1	0	3	575992	6547876
14507	kevad	95	5187	8	163	2611	LL	1	0	3	572951	6546109
14509	kevad	95	5189	9	432	2610	HP/TK	1	2	2	572958	6545851
14510	kevad	95	5190	26	432	2610	LL	1	0	3	572958	6545851
14516	kevad	95	5196	14	1000	2609	LL	1	0	3	572958	6545337
14519	kevad	95	5199	1	163	2609	LL	1	0	3	572958	6545080
14527	kevad	95	5207	2	163	2607	HP/TK	1	2	2	572949	6544310
14530	kevad	95	52101	25	432	2607	HP/TK	1	2	2	572954	6544057
14541	kevad	95	52211	25	163	2605	HP/TK	1	0	3	572956	6543292
14545	kevad	95	5225	25	432	2604	HP/TK	1	2	2	572958	6542768
14742	kevad	95	54621	2	1000	2183	HP/TK	1	1	3	570007	6548226
14760	kevad	95	54801	5	1000	2186	HP/TK	1	1	3	569999	6549775
15341	kevad	95	61571	1	432	1308	LL	1	0	3	564005	6542767
15362	kevad	95	61781	1	163	1312	LL	1	0	3	563997	6544601
15761	kevad	95	66131	60	1000	865	HP/TK	1	1	3	560990	6537156
15771	kevad	95	66611	80	163	434	LL	1	0	3	557975	6537644
15774	kevad	95	66641	260	432	434	LL	1	0	3	557973	6537903
15777	kevad	95	66671	140	1000	435	LL	1	0	3	557986	6538162
15780	kevad	95	66701	30	163	435	LL	1	0	3	557991	6538421
16208	kevad	95	71421	2	163	4	LL	1	0	3	554967	6538651
16211	kevad	95	71451	14	432	3	LL	1	0	3	554970	6538390
16214	kevad	95	71481	3	1000	3	LL	1	0	3	554967	6538123

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{cds}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object

Number of observations : 88  
Distance range : 0 - 1500  
AIC : 177.7629

Detection function:

Hazard-rate key function

Detection function parameters

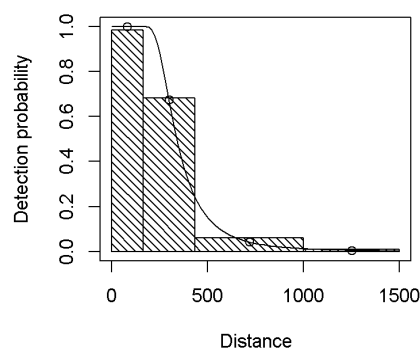
Scale Coefficients:

	estimate	se
(Intercept)	5.729085	0.1609367

Shape parameters:

	estimate	se
(Intercept)	1.310398	0.2119161

	Estimate	SE	CV
Average p	0.2558922	0.03049261	0.1191619
N in covered region	343.8947484	51.76196588	0.1505169



Joonis A.13: Avastamisfunktsioon: kevad – **hahk** *Somateria mollissima*.

## Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy)$   
Mudeli koond:

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-27.554	4.824	-5.712	1.45e-08 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

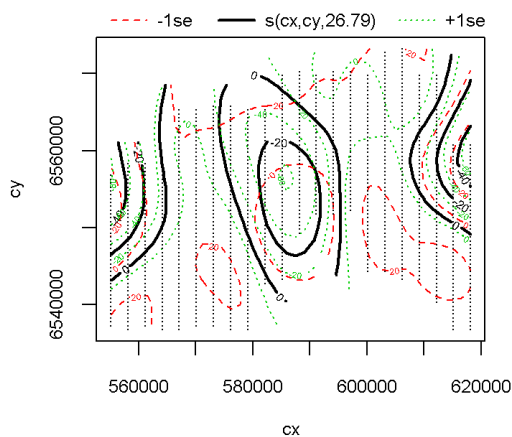
Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	26.79	28.15	8.844	<2e-16 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.22 Deviance explained = 64.8%

GCV = 23.835 Scale est. = 57.071 n = 1099



Joonis A.14: Tiheduspinna tunnused: kevad – **hahk** *Somateria mollissima*.

## Aul *Clangula hyemalis*

### Andmetabel

Tabel A.8: Andmetabel: kevad – aul.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
11040	kevad	93	12002	25	432	7816	HP/TK	1	1	3		608965	6556931
11460	kevad	93	16622	1800	1000	7402	LL	1	0	3		605991	6565512
11463	kevad	93	16652	40	432	7402	LL	1	0	3		605996	6565770
11588	kevad	93	18262	20	1000	6977	LL	1	1	3		603000	6569468
11615	kevad	93	18532	50	432	6973	LL	1	1	3		602986	6567073
11691	kevad	93	19292	3	163	6959	HP/TK	1	0	3		602976	6560470
11733	kevad	93	19713	5	163	6952	HP/TK	1	0	3		602969	6556779
11790	kevad	93	20282	6	432	6942	HP/TK	1	0	3		602985	6551964
11793	kevad	93	20313	30	432	6942	HP/TK	1	0	3		602976	6551709
11797	kevad	93	20352	30	163	6941	HP/TK	1	1	3		602973	6551449

11806	kevad	93	20442	200	1000	6940	HP/TK	1	1	3	602983	6550673
11809	kevad	93	20472	200	432	6939	HP/TK	1	1	3	602977	6550416
11812	kevad	93	20502	2	432	6939	HP/TK	1	1	3	602979	6550158
11817	kevad	93	20552	1	1000	6938	HP/TK	1	0	3	602995	6549652
11863	kevad	93	21013	10	432	6930	HP/TK	1	1	3	603001	6545723
11964	kevad	93	22442	150	432	6510	HP/TK	1	1	3	599981	6551511
11966	kevad	93	22462	200	1000	6510	HP/TK	1	0	3	599970	6551765
11980	kevad	93	22602	20	163	6513	LL	1	0	3	599975	6553034
11983	kevad	93	22632	40	432	6513	LL	1	0	3	599975	6553292
11986	kevad	93	22662	12	432	6514	LL	1	0	3	599971	6553552
12073	kevad	93	23531	12	432	6529	LL	1	0	3	599995	6561141
12112	kevad	93	23922	42	163	6535	LL	1	0	3	599998	6564447
12118	kevad	93	23982	28	432	6536	LL	1	0	3	600003	6564959
12372	kevad	93	27001	1	432	6081	LL	1	0	3	597008	6553137
12375	kevad	93	27031	18	432	6080	LL	1	0	3	597018	6552871
12378	kevad	93	27061	8	163	6080	LL	1	0	3	597028	6552606
12394	kevad	93	27662	3	163	5648	HP/TK	1	1	3	594066	6552505
12398	kevad	93	27702	200	432	5649	LL	1	0	3	594066	6553035
12401	kevad	93	27732	200	163	5649	LL	1	0	3	594066	6553295
12404	kevad	93	27762	300	1000	5650	LL	1	0	3	594071	6553556
12769	kevad	93	31812	22	432	5220	LL	1	1	3	590996	6554964
13320	kevad	93	38341	12	163	4340	LL	1	0	3	584967	6546628
13323	kevad	93	38371	80	432	4339	LL	1	0	3	584961	6546358
13325	kevad	93	38391	300	1000	4339	HP/TK	1	2	2	584961	6546084
13326	kevad	93	38401	120	1000	4339	LL	1	0	3	584961	6546084
13409	kevad	93	39691	2	163	3908	LL	1	0	3	581990	6546888
13666	kevad	93	42641	2	163	3506	LL	1	0	3	578965	6561740
13798	kevad	93	43961	11	432	3483	LL	1	0	3	578984	6550245
13801	kevad	93	43991	4	163	3482	LL	1	0	3	578981	6549982
13834	kevad	93	44321	12	163	3477	LL	1	0	2	578957	6547103
13863	kevad	93	44611	2	432	3472	HP/TK	1	2	2	579000	6544520
14003	kevad	93	46451	20	163	3033	HP/TK	1	1	3	575988	6541193
14025	kevad	93	46671	21	432	3036	LL	1	0	3	575974	6542974
14062	kevad	93	47041	170	163	3043	HP/TK	1	0	3	575984	6546078
14071	kevad	93	47131	4	432	3044	HP/TK	1	0	3	575989	6546849
14217	kevad	93	48591	2	163	3070	LL	1	0	2	575970	6559752
14220	kevad	93	48621	4	432	3071	LL	1	0	2	575965	6560013
14223	kevad	93	48651	6	432	3071	LL	1	0	2	575969	6560273
14351	kevad	93	50312	2	163	2638	LL	1	1	3	572909	6559732
14428	kevad	93	51081	12	432	2625	HP/TK	1	2	2	572969	6553007
14491	kevad	93	51711	30	432	2613	HP/TK	1	2	2	572940	6547420
14513	kevad	93	5193	20	163	2610	LL	1	0	3	572956	6545596
14514	kevad	93	5194	250	432	2610	HP/TK	1	0	3	572956	6545596
14534	kevad	93	5214	250	163	2606	LL	1	0	3	572960	6543806
14537	kevad	93	5217	210	432	2606	LL	1	0	3	572961	6543554
14687	kevad	93	54071	15	163	2173	HP/TK	1	0	3	569999	6543284
14688	kevad	93	54081	70	432	2174	HP/TK	1	1	3	569998	6543550
14737	kevad	93	54571	180	432	2182	LL	1	0	3	570017	6547706
14738	kevad	93	54581	280	163	2182	HP/TK	1	0	3	570017	6547706
14747	kevad	93	54671	350	432	2183	HP/TK	1	0	3	570003	6548490
14762	kevad	93	54821	400	432	2186	HP/TK	1	0	3	569999	6549775
14765	kevad	93	54851	40	432	2187	HP/TK	1	0	3	569997	6550029
14994	kevad	93	57541	15	163	1776	LL	1	1	3	566959	6560996
14997	kevad	93	57571	20	432	1776	LL	1	1	3	566960	6560739
15311	kevad	93	61271	180	432	1303	LL	1	0	3	563988	6540171
15314	kevad	93	61301	45	432	1303	LL	1	0	3	563988	6540428
15344	kevad	93	61601	4	163	1309	LL	1	0	3	564006	6543030
15356	kevad	93	61721	65	163	1311	LL	1	0	3	564011	6544077
15404	kevad	93	62201	2	163	1319	LL	1	0	3	563992	6548263
15786	kevad	93	66761	4	432	436	LL	1	0	3	557992	6538939

## Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{cds}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

Valitud avastamisfunktsioon: hazard-rate key function

Mudeli koond:

Summary for ds object

Number of observations : 70  
Distance range : 0 - 1500  
AIC : 137.4807

Detection function:

Hazard-rate key function

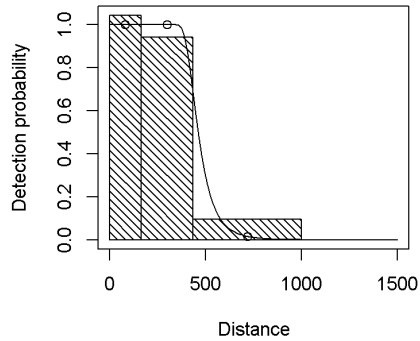
Detection function parameters

Scale Coefficients:  
estimate se  
(Intercept) 6.09259 0.3843215

Shape parameters:

estimate se  
(Intercept) 2.142485 2.488176

	Estimate	SE	CV
Average p	0.3195412	0.05135515	0.1607153
N in covered region	219.0640538	41.30402285	0.1885477



Joonis A.15: Avastamisfunktsioon: kevad – **aul** *Clangula hyemalis*.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:

$D \sim s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-34.366	5.754	-5.973	3.18e-09 ***

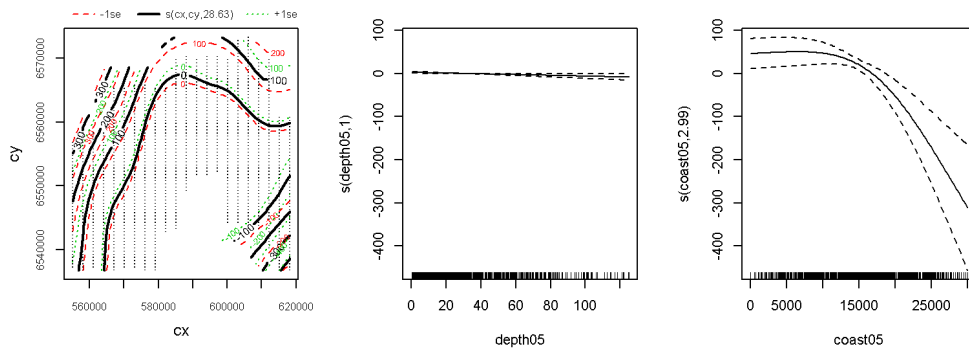
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	28.629	28.968	3.854	5.26e-11 ***
s(depth05)	1.000	1.000	5.401	0.0203 *
s(coast05)	2.993	2.999	8.043	2.65e-05 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.235    Deviance explained = 56.6%  
 GCV = 78.024    Scale est. = 155.06    n = 1097



Joonis A.16: Tiheduspinna tunnused: kevad – aul *Clangula hyemalis*.

## Sõtkas *Bucephala clangula*

### Andmetabel

Tabel A.9: Andmetabel: kevad – sõtkas.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
10606	kevad	90	7262	10	432	8225	HP/TK	1	1	3	611980	6545173
10612	kevad	90	73211	20	432	8226	HP/TK	1	1	3	611985	6545687
13033	kevad	90	35091	1	163	4816	LL	1	0	3	587996	6568660
13966	kevad	90	46081	2	163	3026	HP/TK	1	0	3	575983	6537940
15062	kevad	90	58221	2	163	1764	HP/TK	1	2	2	566962	6554886
15243	kevad	90	60031	2	163	1733	LL	1	1	3	566982	6539212
15432	kevad	90	62481	1	163	1324	HP/TK	1	0	3	564011	6550592
15436	kevad	90	62521	1	432	1325	HP/TK	1	2	2	564006	6551111
15442	kevad	90	62581	2	432	1326	HP/TK	1	2	2	564002	6551630
16100	kevad	90	70341	3	432	22	LL	1	0	3	554940	6547941

### Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{cds}(\text{key} = \text{"hn"}, \text{formula} = \sim 1)$

Valitud avastamisfunktsioon: half-normal key function

Mudeli koond:

Summary for ds object

Number of observations : 10  
 Distance range : 0 - 1500  
 AIC : 16.94175

Detection function:

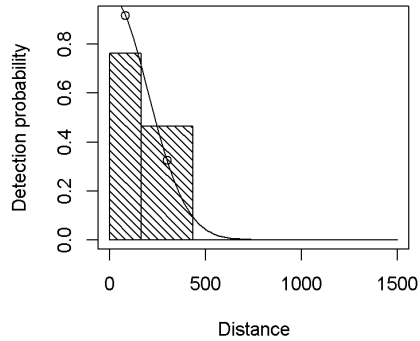
Half-normal key function

Detection function parameters

Scale Coefficients:

estimate se  
 (Intercept) 5.296569 0.3979508

Estimate SE CV  
 Average p 0.1668166 0.06638511 0.3979526  
 N in covered region 59.9460732 29.47034864 0.4916143



Joonis A.17: Avastamisfunktsioon: kevad – sõtkas *Bucephala clangula*.

### Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy)$   
 Mudeli koond:

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-1.043e+03	4.426e-02	-23565	<2e-16 ***

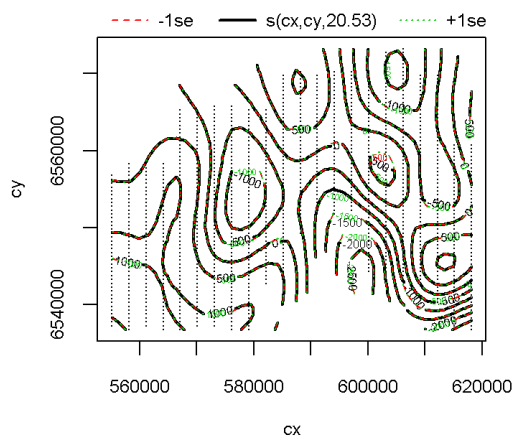
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	20.53	21.79	1.944e+09	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.996 Deviance explained = 99%  
 GCV = 0.025987 Scale est. = 1.1128e-08 n = 1099



Joonis A.18: Tiheduspinna tunnused: kevad – **sõtkas** *Bucephala clangula*.















3607	suvi	283	3607	2	163	1324	LL	0	1	563976	6550934
3608	suvi	256	3608	1	432	1324	TV	1	1	563976	6550934
3624	suvi	256	3624	1	432	1329	TV	1	1	563978	6553045
3626	suvi	283	3626	1	163	1329	TV	1	1	563976	6553308
3628	suvi	283	3628	1	432	1330	TV	1	1	563971	6553572
3631	suvi	283	3631	2	163	1331	LL	0	1	563971	6554109
3633	suvi	283	3633	1	432	1331	LL	0	1	563974	6554383
3634	suvi	283	3634	1	432	1331	TV	1	1	563974	6554383
3635	suvi	283	3635	1	163	1332	LL	0	1	563975	6554657
3638	suvi	2	3638	2	163	1332	TV	1	1	563979	6554931
3643	suvi	283	3643	1	163	1334	LL	0	1	563984	6555745
36591	suvi	256	3659	1	163	1338	LL	0	1	563997	6557894
3660	suvi	255	3660	1	432	1338	TV	1	1	563997	6557894
36721	suvi	283	3672	1	163	904	TV	2	2	560997	6556870
3678	suvi	283	3678	10	432	903	TV	2	2	560990	6556095
3694	suvi	258	3694	1	432	899	TV	2	2	561007	6554033
3738	suvi	283	3738	1	163	887	TV	2	2	561017	6548417
3740	suvi	283	3740	2	432	887	TV	2	2	561030	6548169
3765	suvi	256	3765	3	432	880	LL	0	1	561011	6544811
3778	suvi	283	3778	1	163	877	TV	2	2	560986	6543217
38181	suvi	283	3818	1	163	866	TV	2	2	561005	6537904
3827	suvi	256	3827	1	163	433	LL	0	1	557981	6537288
3829	suvi	256	3829	2	432	434	LL	0	1	557997	6537554
38711	suvi	256	3871	90	432	445	LL	0	1	557994	6543223
3873	suvi	255	3873	20	432	445	LL	0	1	557988	6543489
3878	suvi	286	3878	1	163	447	TV	1	2	557975	6544022
3891	suvi	283	3891	1	432	450	LL	0	1	557976	6545916
3897	suvi	283	3897	2	163	452	LL	0	1	557966	6546718
3923	suvi	283	3923	1	163	459	LL	0	1	557990	6550209
3927	suvi	283	3927	1	432	460	LL	0	1	557988	6550746
3931	suvi	255	3931	1	432	461	LL	0	1	557977	6551282
3933	suvi	256	3933	1	163	462	LL	0	1	557969	6551550
3937	suvi	95	3937	20	432	463	LL	0	1	557966	6552086
3939	suvi	95	3939	30	1000	463	LL	0	1	557971	6552357
3941	suvi	95	3941	14	163	464	LL	0	1	557978	6552627
3989	suvi	283	3989	1	163	35	LL	0	1	554946	6554269
3994	suvi	283	3994	1	163	34	TV	2	2	554932	6553784
3999	suvi	258	3999	1	163	33	LL	0	1	554945	6553053
4003	suvi	256	4003	1	1000	32	LL	0	1	554952	6552551
4018	suvi	283	4018	1	432	28	TV	2	2	554905	6550789
4060	suvi	255	4060	10	432	17	TV	2	2	554967	6545400
40681	suvi	95	4068	1	163	15	TV	2	2	554947	6544393
4075	suvi	283	4075	1	432	13	LL	0	1	554917	6543340
4077	suvi	258	4077	1	432	13	LL	0	1	554921	6543075
4078	suvi	255	4078	1	432	13	TV	2	2	554921	6543075
4079	suvi	256	4079	2	432	12	LL	0	1	554927	6542815
4080	suvi	255	4080	2	432	12	TV	2	2	554927	6542815
4081	suvi	256	4081	2	432	12	LL	0	1	554923	6542555
4082	suvi	256	4082	1	163	12	TV	2	2	554923	6542555
4083	suvi	256	4083	2	163	11	LL	0	1	554915	6542299
4084	suvi	283	4084	1	432	11	TV	2	2	554915	6542299
4085	suvi	256	4085	3	163	11	LL	0	1	554908	6542042
4087	suvi	258	4087	2	163	10	LL	0	1	554903	6541780
4111	suvi	255	4111	4	432	9153	LL	0	1	554897	6538644
4113	suvi	255	4113	2	432	9166	LL	0	1	554898	6538385

## Avastamisfunktsioon

Mudeli võrrand:  $\sim mc ds(\text{key} = \text{"hr"}, \text{formula} = \sim \text{obs})$

Valitud avastamisfunktsioon: hazard-rate key function

Mudeli koond:

Summary for ds object

Number of observations : 208  
Distance range : 0 - 1500  
AIC : 348.7552

Detection function:

Hazard-rate key function

Detection function parameters

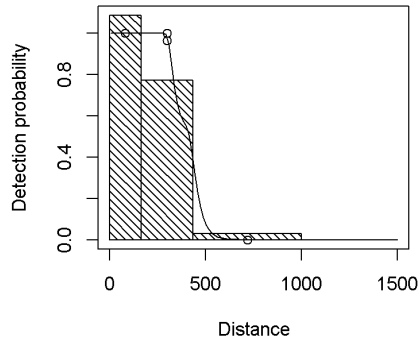
Scale Coefficients:

	estimate	se
(Intercept)	6.0861135	0.2679418
obsTV	-0.3052312	0.1771058

Shape parameters:

	estimate	se
(Intercept)	2.677727	3.309018

	Estimate	SE	CV
Average p	0.268858	0.020372	0.07577234
N in covered region	773.642656	74.548849	0.09636083



Joonis A.19: Avastamisfunktsioon: suvi – kõik liigid.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-1.416e+01	1.309e-04	-108221	<2e-16 ***

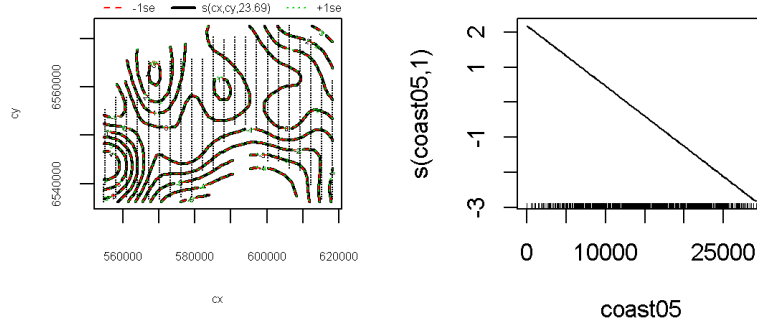
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	23.69	27.22	5207558	<2e-16 ***
s(coast05)	1.00	1.00	966103	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.0443 Deviance explained = 23.4%  
 GCV = 9.3274 Scale est. = 1.5283e-05 n = 1099



Joonis A.20: Tiheduspinna tunnused: suvi – kõik liigid.

## Kajakad Andmetabel

Tabel A.11: Andmetabel: suvi – kajakad.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
	30	suvi	255	30	1	163	9080	TV	1	1		618087	6540648
	53	suvi	256	53	1	432	9087	LL	1	1		618094	6544121
	55	suvi	255	55	1	432	9087	LL	1	1		618085	6544412
	58	suvi	255	58	1	432	9088	TV	1	1		618065	6544699
	591	suvi	256	59	1	163	9088	LL	1	1		618043	6544981
	60	suvi	255	60	1	163	9088	TV	1	1		618043	6544981
	62	suvi	255	62	2	163	9089	TV	1	1		618029	6545264
	66	suvi	255	66	1	163	9090	TV	1	1		618030	6545824
	117	suvi	256	117	1	432	9104	LL	1	1		618030	6552969
	119	suvi	256	119	1	1000	9105	LL	1	1		618040	6553240
	140	suvi	255	140	1	163	9110	TV	1	1		617990	6555947
	1612	suvi	266	161	2	432	9117	LL	1	1		617966	6559063
	162	suvi	255	162	1	432	9117	TV	1	1		617966	6559063
	163	suvi	266	163	2	432	9117	LL	1	1		617961	6559335
	1651	suvi	256	165	1	432	9118	LL	1	1		617961	6559607
	166	suvi	255	166	1	163	9118	TV	1	1		617961	6559607
	167	suvi	256	167	2	432	9118	LL	1	1		617966	6559875
	1691	suvi	256	169	1	163	9119	LL	1	1		617976	6560144
	171	suvi	256	171	1	1000	9119	LL	1	1		617979	6560416
	173	suvi	255	173	1	163	9120	LL	1	1		617978	6560683
	298	suvi	256	298	1	163	8658	TV	2	1		614964	6545662
	346	suvi	255	346	10	163	8645	TV	2	1		614982	6539423
	354	suvi	255	354	1	432	8643	TV	2	1		614976	6538402
	413	suvi	255	413	1	163	8227	LL	1	1		611975	6546012
	467	suvi	255	467	14	163	8241	LL	1	1		611975	6553067
	470	suvi	263	470	4	163	8241	TV	2	1		611966	6553325
	487	suvi	263	487	1	163	8246	LL	1	1		612012	6555666
	4891	suvi	263	489	1	432	8246	LL	1	1		612009	6555928
	491	suvi	255	491	1	432	8247	LL	1	1		612000	6556188
	506	suvi	255	506	1	163	8251	TV	2	1		611971	6558017
	584	suvi	255	584	1	163	8271	TV	2	1		611926	6568244
	601	suvi	256	601	1	163	7842	LL	2	1		608938	6569663
	602	suvi	256	602	1	163	7842	TV	1	1		608938	6569663
	862	suvi	255	862	2	432	7371	TV	2	1		606030	6550072
	875	suvi	255	875	4	163	7374	LL	0	1		605996	6551929
	876	suvi	255	876	1	163	7374	TV	2	1		605996	6551929
	877	suvi	255	877	2	432	7375	LL	0	1		605996	6552189
	887	suvi	256	887	1	1000	7377	LL	0	1		606027	6553494
	895	suvi	263	895	1	163	7380	LL	0	1		606025	6554584
	905	suvi	266	905	1	163	7382	LL	0	1		605996	6555905
	907	suvi	266	907	1	163	7383	LL	0	1		605994	6556170
	929	suvi	256	929	1	432	7389	LL	0	1		606013	6559103
	992	suvi	255	992	1	432	7405	TV	2	1		605998	6567321
	1000	suvi	255	1000	1	432	7407	TV	2	1		606019	6568395
	10071	suvi	256	1007	2	163	7409	LL	0	1		606012	6569474
	1010	suvi	255	1010	1	432	7410	TV	2	1		606013	6569744
	1014	suvi	255	1014	1	163	7411	TV	2	1		606011	6570281
	1020	suvi	255	1020	2	432	7413	TV	2	1		606014	6571077
	1113	suvi	256	1113	1	432	6965	LL	1	1		602968	6563110
	1118	suvi	255	1118	1	432	6964	TV	2	1		602975	6562584
	1128	suvi	255	1128	1	163	6961	TV	2	1		602932	6561305
	1138	suvi	255	1138	1	432	6958	TV	2	1		602940	6559996
	1146	suvi	255	1146	3	432	6956	TV	2	1		602968	6558974
	11692	suvi	256	1169	1	163	6950	LL	1	1		602941	6555875
	1178	suvi	255	1178	20	432	6948	TV	2	1		602957	6554855
	1190	suvi	255	1190	1	163	6945	TV	2	1		602956	6553316
	1273	suvi	255	1273	3	163	6499	LL	0	1		599974	6546380
	1275	suvi	255	1275	2	432	6500	LL	0	1		599978	6546643
	1304	suvi	255	1304	1	163	6507	TV	1	1		599985	6550383
	1366	suvi	255	1366	1	163	6524	TV	1	1		600001	6558727
	1367	suvi	256	1367	1	432	6524	LL	0	1		600001	6558995
	1375	suvi	256	1375	1	1000	6527	LL	0	1		600014	6560077





3255	suvi	255	3255	1	432	2210	LL	0	1	569999	6561724
3258	suvi	255	3258	1	432	2210	TV	2	1	569990	6561990
3297	suvi	255	3297	2	432	1782	LL	1	1	566917	6563874
3306	suvi	255	3306	1	432	1780	TV	2	1	566907	6562815
33101	suvi	256	3310	1	432	1779	TV	2	1	566904	6562287
3317	suvi	258	3317	1	432	1777	LL	1	1	566923	6561207
3353	suvi	258	3353	1	432	1767	LL	1	1	566977	6556458
3395	suvi	256	3395	1	163	1756	LL	1	1	566978	6550928
3410	suvi	255	3410	1	432	1753	TV	2	1	566997	6549096
3512	suvi	255	3512	1	432	1299	TV	1	2	563963	6538233
3517	suvi	256	3517	2	432	1301	LL	0	2	563974	6539065
3591	suvi	255	3591	1	432	1320	LL	0	1	563992	6548864
3596	suvi	256	3596	1	432	1321	TV	1	1	563974	6549374
3608	suvi	256	3608	1	432	1324	TV	1	1	563976	6550934
3624	suvi	256	3624	1	432	1329	TV	1	1	563978	6553045
36591	suvi	256	3659	1	163	1338	LL	0	1	563997	6557894
3660	suvi	255	3660	1	432	1338	TV	1	1	563997	6557894
3694	suvi	258	3694	1	432	899	TV	2	2	561007	6554033
3765	suvi	256	3765	3	432	880	LL	0	1	561011	6544811
3827	suvi	256	3827	1	163	433	LL	0	1	557981	6537288
3829	suvi	256	3829	2	432	434	LL	0	1	557997	6537554
38711	suvi	256	3871	90	432	445	LL	0	1	557994	6543223
3873	suvi	255	3873	20	432	445	LL	0	1	557988	6543489
3931	suvi	255	3931	1	432	461	LL	0	1	557977	6551282
3933	suvi	256	3933	1	163	462	LL	0	1	557969	6551550
3999	suvi	258	3999	1	163	33	LL	0	1	554945	6553053
4003	suvi	256	4003	1	1000	32	LL	0	1	554952	6552551
4060	suvi	255	4060	10	432	17	TV	2	2	554967	6545400
4077	suvi	258	4077	1	432	13	LL	0	1	554921	6543075
4078	suvi	255	4078	1	432	13	TV	2	2	554921	6543075
4079	suvi	256	4079	2	432	12	LL	0	1	554927	6542815
4080	suvi	255	4080	2	432	12	TV	2	2	554927	6542815
4081	suvi	256	4081	2	432	12	LL	0	1	554923	6542555
4082	suvi	256	4082	1	163	12	TV	2	2	554923	6542555
4083	suvi	256	4083	2	163	11	LL	0	1	554915	6542299
4085	suvi	256	4085	3	163	11	LL	0	1	554908	6542042
4087	suvi	258	4087	2	163	10	LL	0	1	554903	6541780
4111	suvi	255	4111	4	432	9153	LL	0	1	554897	6538644
4113	suvi	255	4113	2	432	9166	LL	0	1	554898	6538385

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{mcds}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{obs})$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object

Number of observations : 208  
Distance range : 0 - 1500  
AIC : 348.7552

Detection function:

Hazard-rate key function

Detection function parameters

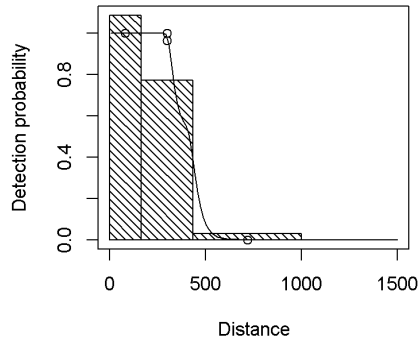
Scale Coefficients:

	estimate	se
(Intercept)	6.0861135	0.2679418
obsTV	-0.3052312	0.1771058

Shape parameters:

	estimate	se
(Intercept)	2.677727	3.309018

	Estimate	SE	CV
Average p	0.268858	0.020372	0.07577234
N in covered region	773.642656	74.548849	0.09636083



Joonis A.21: Avastamisfunktsioon: suvi – kajakad.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-1.416e+01	1.309e-04	-108221	<2e-16 ***

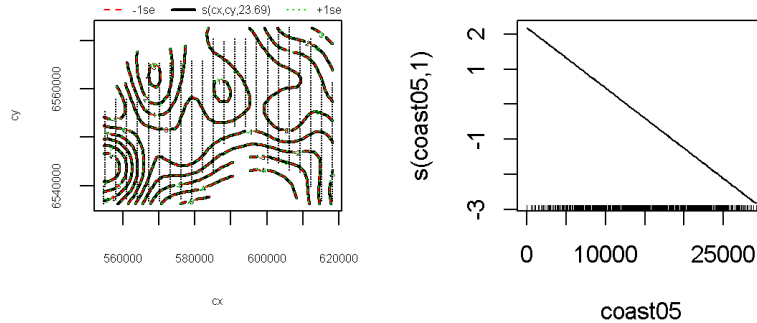
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	23.69	27.22	5207558	<2e-16 ***
s(coast05)	1.00	1.00	966103	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.0443 Deviance explained = 23.4%  
 GCV = 9.3274 Scale est. = 1.5283e-05 n = 1099



Joonis A.22: Tiheduspinna tunnused: suvi – kajakad.

## Tiirud Andmetabel

Tabel A.12: Andmetabel: suvi – tiirud.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
551	suvi	282	551	1	432	8263	LL	1	1		611954	6564071
943	suvi	283	943	1	432	7392	LL	0	1		606001	6560965
945	suvi	283	945	2	432	7393	LL	0	1		605997	6561233
957	suvi	283	957	2	163	7396	LL	0	1		605988	6562802
959	suvi	283	959	1	432	7397	LL	0	1		605997	6563063
960	suvi	283	960	1	163	7397	TV	2	1		605997	6563063
1018	suvi	283	1018	1	432	7412	TV	2	1		606012	6570812
1129	suvi	283	1129	1	163	6961	LL	1	1		602935	6561048
1391	suvi	283	1391	3	163	6531	LL	0	1		600009	6562252
1441	suvi	283	1441	1	163	6544	LL	0	1		600008	6568963
1468	suvi	283	1468	1	432	6110	TV	1	1		596968	6567994
1498	suvi	283	1498	1	163	6103	TV	1	1		597001	6564122
1499	suvi	283	1499	2	432	6102	LL	1	1		596995	6563857
1504	suvi	283	1504	1	163	6101	TV	1	1		596979	6563330
1508	suvi	283	1508	2	163	6100	TV	1	1		596981	6562799
1511	suvi	283	1511	1	432	6099	LL	1	1		596996	6562263
1512	suvi	283	1512	1	163	6099	TV	1	1		596996	6562263
1562	suvi	283	1562	1	432	6086	TV	1	1		597042	6555746
1574	suvi	283	1574	2	432	6083	TV	1	1		597026	6554171
16351	suvi	283	1635	2	432	5658	LL	0	1		594051	6557603
1770	suvi	283	1770	1	163	5240	TV	2	0		591041	6564904
1774	suvi	283	1774	1	163	5239	TV	2	0		591024	6564389
1838	suvi	283	1838	1	432	5222	TV	2	0		591007	6555945
1915	suvi	283	1915	1	163	4788	LL	0	0		588030	6554746
1922	suvi	283	1922	1	432	4790	TV	2	0		588012	6555505
1965	suvi	283	1965	1	163	4801	LL	0	0		588018	6561300
2081	suvi	283	2081	1	432	4374	LL	1	0		584984	6563736
21081	suvi	283	2108	1	163	4367	TV	1	0		585002	6560328
2141	suvi	283	2141	1	163	4358	LL	1	0		585032	6555896
2166	suvi	283	2166	1	163	4352	TV	1	0		585042	6552800
2200	suvi	283	2200	1	432	4343	TV	1	0		585006	6548328
2304	suvi	283	2304	1	432	3916	TV	1	1		582017	6550839
2370	suvi	283	2370	1	163	3933	TV	1	1		582008	6559317
2429	suvi	283	2429	1	163	3511	LL	1	0		578980	6564272
2518	suvi	283	2518	1	163	3488	TV	2	1		578951	6552739
2526	suvi	283	2526	2	432	3486	TV	2	1		578991	6551684
2570	suvi	283	2570	4	432	3474	TV	2	1		579011	6545844
2584	suvi	283	2584	2	432	3470	TV	2	1		578951	6543936
2647	suvi	283	2647	8	432	3028	LL	0	1		575956	6538540
2649	suvi	283	2649	1	163	3028	LL	0	1		575955	6538791
2743	suvi	283	2743	1	163	3052	LL	0	1		575961	6550886
2745	suvi	283	2745	2	163	3053	LL	0	1		575964	6551145
2834	suvi	283	2834	1	163	3076	TV	2	1		575979	6562883
2925	suvi	283	2925	1	163	2631	LL	1	1		573010	6556138
3085	suvi	283	3085	3	432	2165	LL	0	1		569994	6539057
3128	suvi	283	3128	2	432	2176	TV	2	1		569987	6544560
3155	suvi	283	3155	2	432	2183	LL	0	1		570004	6548303
3161	suvi	283	3161	1	432	2185	LL	0	1		569997	6549096
3165	suvi	283	3165	3	163	2186	LL	0	1		570003	6549634
3178	suvi	283	3178	3	163	2189	TV	2	1		570016	6551243
3223	suvi	283	3223	1	163	2201	LL	0	1		570004	6557410
3229	suvi	283	3229	1	163	2203	LL	0	1		570018	6558224
3233	suvi	283	3233	1	163	2204	LL	0	1		570028	6558762
3239	suvi	283	3239	1	432	2206	LL	0	1		570034	6559575
3246	suvi	283	3246	1	432	2207	TV	2	1		570023	6560370
3277	suvi	283	3277	1	432	2216	LL	0	1		570004	6564684
3279	suvi	283	3279	1	163	2216	LL	0	1		569995	6564946
3280	suvi	283	3280	2	432	2216	TV	2	1		569995	6564946
3293	suvi	283	3293	1	163	1783	LL	1	1		566921	6564396
3295	suvi	283	3295	1	432	1783	LL	1	1		566921	6564134
3316	suvi	283	3316	1	432	1777	TV	2	1		566916	6561481
3567	suvi	283	3567	1	432	1314	LL	0	2		563976	6545749

3568	suvi	283	3568	1	163	1314	TV	1	2	563976	6545749
3569	suvi	283	3569	1	1000	1315	LL	0	2	563983	6546012
3589	suvi	283	3589	1	163	1320	LL	0	1	563992	6548607
3604	suvi	283	3604	1	432	1323	TV	1	1	563962	6550406
3607	suvi	283	3607	2	163	1324	LL	0	1	563976	6550934
3626	suvi	283	3626	1	163	1329	TV	1	1	563976	6553308
3628	suvi	283	3628	1	432	1330	TV	1	1	563971	6553572
3631	suvi	283	3631	2	163	1331	LL	0	1	563971	6554109
3633	suvi	283	3633	1	432	1331	LL	0	1	563974	6554383
3634	suvi	283	3634	1	432	1331	TV	1	1	563974	6554383
3635	suvi	283	3635	1	163	1332	LL	0	1	563975	6554657
3643	suvi	283	3643	1	163	1334	LL	0	1	563984	6555745
36721	suvi	283	3672	1	163	904	TV	2	2	560997	6556870
3678	suvi	283	3678	10	432	903	TV	2	2	560990	6556095
3738	suvi	283	3738	1	163	887	TV	2	2	561017	6548417
3740	suvi	283	3740	2	432	887	TV	2	2	561030	6548169
3778	suvi	283	3778	1	163	877	TV	2	2	560986	6543217
38181	suvi	283	3818	1	163	866	TV	2	2	561005	6537904
3891	suvi	283	3891	1	432	450	LL	0	1	557976	6545916
3897	suvi	283	3897	2	163	452	LL	0	1	557966	6546718
3923	suvi	283	3923	1	163	459	LL	0	1	557990	6550209
3927	suvi	283	3927	1	432	460	LL	0	1	557988	6550746
3989	suvi	283	3989	1	163	35	LL	0	1	554946	6554269
3994	suvi	283	3994	1	163	34	TV	2	2	554932	6553784
4018	suvi	283	4018	1	432	28	TV	2	2	554905	6550789
4075	suvi	283	4075	1	432	13	LL	0	1	554917	6543340
4084	suvi	283	4084	1	432	11	TV	2	2	554915	6542299

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{cds}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object

Number of observations : 89  
Distance range : 0 - 1500  
AIC : 136.9226

Detection function:

Hazard-rate key function

Detection function parameters

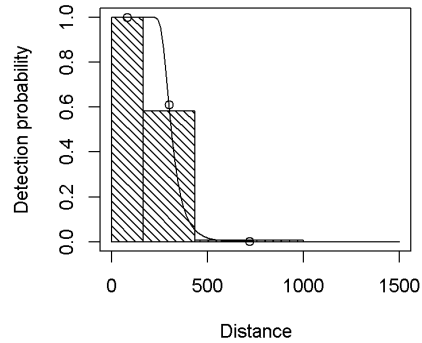
Scale Coefficients:

	estimate	se
(Intercept)	5.690756	0.1280055

Shape parameters:

	estimate	se
(Intercept)	2.023426	0.3521579

	Estimate	SE	CV
Average p	0.2163697	0.0226632	0.1047429
N in covered region	411.3329556	57.8444690	0.1406269



Joonis A.23: Avastamisfunktsioon: suvi – tiirud.

### Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy)$   
 Mudeli koond:

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy)$

#### Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-1.541e+01	1.898e-04	-81155	<2e-16 ***

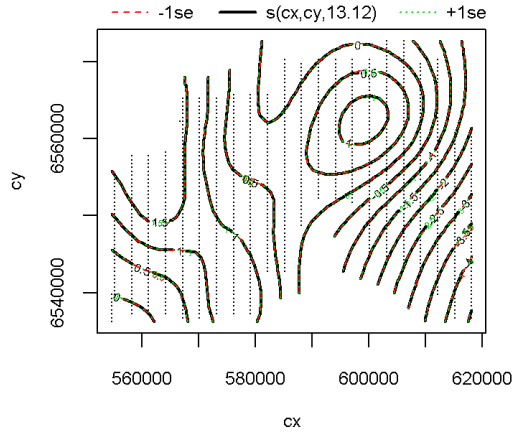
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	13.12	17.33	3894695	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.0288 Deviance explained = 16%  
 GCV = 2.8997 Scale est. = 4.7295e-06 n = 1099



Joonis A.24: Tiheduspinna tunnused: suvi – tiirud.

## Vaerad

### Andmetabel

Tabel A.13: Andmetabel: suvi – vaerad.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
111	suvi	97	111	40	432	9103	LL	1	1	1	1	617982	6552167
113	suvi	97	113	80	1000	9103	LL	1	1	1	1	617996	6552432
1151	suvi	97	115	60	432	9104	LL	1	1	1	1	618015	6552698
121	suvi	97	121	4	163	9106	LL	1	1	1	1	618045	6553508
125	suvi	97	125	26	432	9107	LL	1	1	1	1	618014	6554044
127	suvi	97	127	8	432	9107	LL	1	1	1	1	617990	6554318
129	suvi	97	129	20	1000	9108	LL	1	1	1	1	617969	6554589
131	suvi	97	131	140	1000	9108	LL	1	1	1	1	617957	6554863
133	suvi	97	133	150	432	9109	LL	1	1	1	1	617957	6555137
135	suvi	97	135	140	432	9109	LL	1	1	1	1	617965	6555408
137	suvi	97	137	200	1000	9110	LL	1	1	1	1	617978	6555680
1392	suvi	97	139	70	432	9110	LL	1	1	1	1	617990	6555947
141	suvi	97	141	1	1000	9111	LL	1	1	1	1	618000	6556220
142	suvi	97	142	3	163	9111	TV	1	1	1	1	618000	6556220
143	suvi	97	143	4	1000	9111	LL	1	1	1	1	618007	6556493
144	suvi	97	144	16	163	9111	TV	1	1	1	1	618007	6556493
145	suvi	97	145	16	432	9112	LL	1	1	1	1	618007	6556771
148	suvi	97	148	80	432	9113	TV	1	1	1	1	618007	6557048
149	suvi	97	149	8	432	9113	LL	1	1	1	1	618000	6557325
150	suvi	97	150	2	163	9113	TV	1	1	1	1	618000	6557325
232	suvi	97	232	10	432	8675	TV	2	1	1	1	615020	6554374
234	suvi	99	234	2	163	8675	TV	2	1	1	1	615021	6554112
241	suvi	97	241	50	432	8673	LL	2	1	1	1	614990	6553047
243	suvi	97	243	350	1000	8672	LL	2	1	1	1	614986	6552788
247	suvi	97	247	120	432	8671	LL	2	1	1	1	614987	6552264
253	suvi	99	253	3	432	8669	LL	2	1	1	1	615008	6551477
284	suvi	97	284	3	163	8662	TV	2	1	1	1	614996	6547501
290	suvi	97	290	1	163	8660	TV	2	1	1	1	614977	6546721
294	suvi	97	294	1	432	8659	TV	2	1	1	1	614958	6546189
3021	suvi	99	302	1	163	8657	TV	2	1	1	1	614978	6545142
322	suvi	97	322	10	163	8652	TV	2	1	1	1	614905	6542505
324	suvi	97	324	20	163	8651	TV	2	1	1	1	614909	6542245
325	suvi	97	325	80	432	8650	LL	2	1	1	1	614920	6541988
327	suvi	97	327	2	163	8650	LL	2	1	1	1	614927	6541731
329	suvi	97	329	20	432	8649	LL	2	1	1	1	614934	6541475
331	suvi	97	331	12	163	8649	LL	2	1	1	1	614941	6541219
429	suvi	98	429	8	163	8231	LL	1	1	1	1	611960	6548084
439	suvi	97	439	400	432	8233	LL	1	1	1	1	611998	6549390
443	suvi	97	443	32	432	8234	LL	1	1	1	1	611991	6549919
447	suvi	98	447	300	1000	8235	LL	1	1	1	1	611955	6550452
449	suvi	98	449	360	163	8236	LL	1	1	1	1	611941	6550715
455	suvi	98	455	160	432	8237	LL	1	1	1	1	611959	6551490
457	suvi	97	457	400	1000	8238	LL	1	1	1	1	611971	6551752
4811	suvi	98	481	8	163	8244	LL	1	1	1	1	611980	6554880
6701	suvi	97	670	1	163	7824	TV	1	1	1	1	608941	6560737
6741	suvi	97	674	1	163	7823	TV	1	1	1	1	608929	6560213
684	suvi	97	684	2	163	7820	TV	1	1	1	1	608952	6558924
729	suvi	98	729	4	432	7808	LL	1	1	1	1	609011	6552554
734	suvi	99	734	3	163	7807	TV	1	1	1	1	609009	6552032
745	suvi	99	745	20	432	7803	LL	1	2	2	2	609009	6550482
753	suvi	98	753	40	432	7801	LL	1	2	2	2	609013	6549461
755	suvi	99	755	20	163	7801	LL	1	2	2	2	609014	6549206
7571	suvi	99	757	18	163	7800	LL	1	2	2	2	609015	6548947
759	suvi	99	759	20	163	7800	LL	1	2	2	2	609017	6548689
7612	suvi	97	761	80	163	7799	LL	1	2	2	2	609013	6548434

763	suvi	97	763	40	432	7799	LL	1	2	609006	6548176
836	suvi	99	836	5	432	7364	TV	2	1	605988	6546689
839	suvi	98	839	40	163	7365	LL	0	1	606007	6547213
841	suvi	98	841	20	432	7365	LL	0	1	606016	6547468
868	suvi	97	868	5	163	7372	TV	2	1	606015	6550868
872	suvi	97	872	10	163	7373	TV	2	1	606002	6551401
890	suvi	99	890	2	163	7378	TV	2	1	606036	6553770
977	suvi	97	977	20	163	7401	LL	0	1	605988	6565460
979	suvi	97	979	40	432	7402	LL	0	1	605987	6565729
985	suvi	97	985	240	432	7404	LL	0	1	605987	6566527
988	suvi	97	988	1	163	7404	TV	2	1	605989	6566788
989	suvi	97	989	400	1000	7405	LL	0	1	605993	6567056
996	suvi	97	996	3	163	7406	TV	2	1	606006	6567855
1001	suvi	97	1001	80	1000	7408	LL	0	1	606018	6568663
1002	suvi	97	1002	1	163	7408	TV	2	1	606018	6568663
1003	suvi	97	1003	120	432	7408	LL	0	1	606016	6568934
1005	suvi	97	1005	40	163	7409	LL	0	1	606013	6569205
1008	suvi	97	1008	1	163	7409	TV	2	1	606012	6569474
1050	suvi	97	1050	1	163	6981	TV	2	1	602988	6571262
1078	suvi	97	1078	1	163	6974	TV	2	1	602945	6567816
1082	suvi	97	1082	1	163	6973	TV	2	1	602949	6567295
1083	suvi	97	1083	40	163	6973	LL	1	1	602959	6567034
1085	suvi	97	1085	120	432	6972	LL	1	1	602970	6566771
1087	suvi	97	1087	360	1000	6972	LL	1	1	602979	6566505
1090	suvi	97	1090	2	163	6971	TV	2	1	602972	6566241
1103	suvi	97	1103	140	432	6967	LL	1	1	602936	6564416
1105	suvi	97	1105	260	1000	6967	LL	1	1	602938	6564157
1107	suvi	97	1107	200	163	6966	LL	1	1	602942	6563898
1120	suvi	97	1120	10	432	6963	TV	2	1	602969	6562326
1122	suvi	97	1122	3	163	6963	TV	2	1	602959	6562069
1124	suvi	97	1124	10	163	6962	TV	2	1	602953	6561813
1132	suvi	97	1132	6	432	6960	TV	2	1	602938	6560786
1168	suvi	97	1168	5	163	6951	TV	2	1	602943	6561333
1176	suvi	97	1176	5	163	6949	TV	2	1	602954	6555110
11802	suvi	99	1180	3	432	6948	TV	2	1	602963	6554596
1188	suvi	97	1188	25	163	6946	TV	2	1	602957	6553571
1320	suvi	97	1320	10	432	6512	TV	1	1	600016	6552535
1322	suvi	97	1322	5	163	6512	TV	1	1	600014	6552815
1416	suvi	97	1416	5	163	6538	TV	1	1	600035	6565531
1440	suvi	97	1440	2	432	6544	TV	1	1	600006	6568699
1568	suvi	98	1568	2	432	6084	TV	1	1	597038	6554958
1684	suvi	97	1684	1	163	5671	TV	1	1	593978	6564018
1746	suvi	97	1746	5	432	5246	TV	2	0	591065	6567970
1750	suvi	97	1750	10	163	5245	TV	2	0	591065	6567460
1828	suvi	97	1828	3	432	5225	TV	2	0	591053	6557255
1844	suvi	98	1844	4	432	5221	TV	2	0	591010	6555145
1892	suvi	97	1892	1	163	4782	TV	2	0	588006	6551657
1902	suvi	97	1902	2	432	4784	TV	2	0	587995	6552921
2180	suvi	97	2180	3	163	4348	TV	1	0	585023	6550935
2205	suvi	97	2205	20	432	4342	LL	1	0	585015	6547541
2207	suvi	97	2207	180	1000	4341	LL	1	0	585020	6547272
2209	suvi	97	2209	400	432	4341	LL	1	0	585021	6547008
2212	suvi	97	2212	20	432	4340	TV	1	0	585027	6546741
2219	suvi	97	2219	11	432	4338	LL	1	0	585032	6545554
2262	suvi	97	2262	2	163	3905	TV	1	1	581958	6545403
22741	suvi	97	2274	10	163	3908	TV	1	1	582012	6546922
2520	suvi	97	2520	1	432	3487	TV	2	1	578958	6552474
2627	suvi	97	2627	40	432	3458	LL	1	1	578977	6537849
2716	suvi	98	2716	30	432	3045	TV	2	1	575956	6547248
2749	suvi	98	2749	40	1000	3054	LL	0	1	575968	6551670
2935	suvi	99	2935	4	432	2628	LL	1	0	573007	6554819
2956	suvi	97	2956	1	432	2623	TV	2	1	572994	6552153
2979	suvi	98	2979	44	432	2616	LL	1	0	572953	6548973
2981	suvi	98	2981	20	163	2616	LL	1	0	572953	6548712
2983	suvi	98	2983	30	163	2615	LL	1	0	572954	6548449
2989	suvi	99	2989	3	163	2614	LL	1	0	572977	6547641
2991	suvi	97	2991	20	432	2613	LL	1	0	572981	6547371
2993	suvi	97	2993	40	1000	2613	LL	1	0	572983	6547105
2995	suvi	97	2995	120	163	2612	LL	1	0	572983	6546835
2998	suvi	97	2998	5	163	2612	TV	2	1	572982	6546568
3008	suvi	97	3008	1	432	2609	TV	2	1	572973	6545233
3016	suvi	97	3016	1	163	2607	TV	2	1	572968	6544168
3149	suvi	97	3149	2	432	2181	LL	0	1	570010	6547500
3151	suvi	97	3151	1	163	2182	LL	0	1	570011	6547769
3152	suvi	97	3152	2	163	2182	TV	2	1	570011	6547769
3179	suvi	97	3179	80	432	2190	LL	0	1	570013	6551514

## Avastamisfunktsioon

Mudeli vōrrand:  $\sim \text{mc}ds(\text{key} = \text{"hn"}, \text{formula} = \sim \text{obs} + \text{wav})$

Valitud avastamisfunktsioon: half-normal key function

Mudeli koond:

Summary for ds object

Number of observations : 131  
Distance range : 0 - 1500  
AIC : 231.3037

Detection function:

Half-normal key function

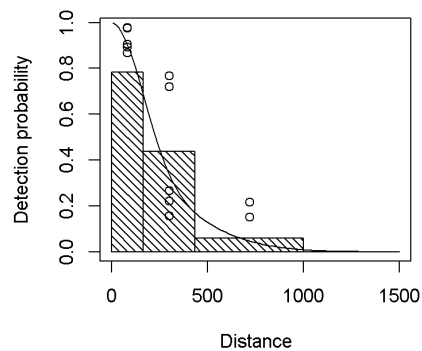
Detection function parameters

Scale Coefficients:



	estimate	se
(Intercept)	6.0174814	0.2548565
obsTV	-0.8669608	0.1793180
wav1	-0.1043758	0.2574441
wav2	-0.8022401	0.4997544

	Estimate	SE	CV
Average p	0.1870769	0.01876428	0.1003025
N in covered region	700.2466222	90.07917669	0.1286392



Joonis A.25: Avastamisfunktsioon: suvi – vaerad.

## Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy)$   
Mudeli koond:

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-32.40923	0.09295	-348.7	<2e-16 ***

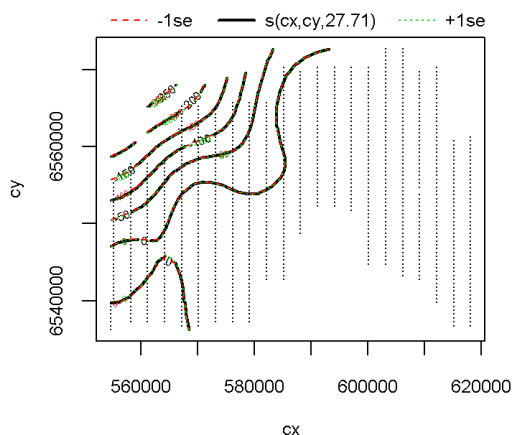
---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	27.71	28.48	16723	<2e-16 ***

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.358 Deviance explained = 61.3%  
GCV = 68.378 Scale est. = 0.069524 n = 1099



Joonis A.26: Tiheduspinna tunnused: suvi – vaerad.

## Alca torda

### Andmetabel

Tabel A.14: Andmetabel: suvi - .

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
175	suvi	286	175	1	432	9120	LL	1	1	1		617973	6560948
1733	suvi	286	1733	8	163	5249	LL	1	0	0		591008	6569487
1739	suvi	286	1739	2	163	5248	LL	1	0	0		591036	6568729
2020	suvi	286	2020	1	163	4816	TV	2	0	0		588000	6568584
2278	suvi	286	2278	1	163	3909	TV	1	1	1		582000	6547436
2296	suvi	286	2296	1	163	3914	TV	1	1	1		582044	6549797
2824	suvi	286	2824	2	432	3074	TV	2	1	1		575973	6561533
28951	suvi	286	2895	1	163	2639	LL	1	1	1		573012	6560098
2946	suvi	286	2946	2	163	2625	TV	2	1	1		573009	6553481
3208	suvi	286	3208	2	163	2197	TV	2	1	1		570034	6555250
3878	suvi	286	3878	1	163	447	TV	1	2	2		557975	6544022

### Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{cdfs}(\text{key} = \text{"hn"}, \text{formula} = \sim 1)$

**Valitud avastamisfunktsioon:** half-normal key function

**Mudeli koond:**

Summary for ds object

Number of observations : 11  
Distance range : 0 - 1500  
AIC : 12.44021

Detection function:

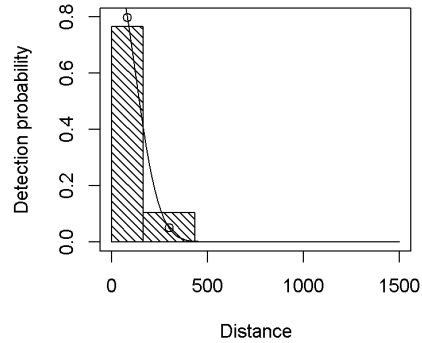
Half-normal key function

Detection function parameters

Scale Coefficients:

	estimate	se
(Intercept)	4.807317	0.2674094

	Estimate	SE	CV
Average p	0.1022728	0.0273488	0.2674104
N in covered region	107.5555260	42.0870577	0.3913054



Joonis A.27: Avastamisfunktsioon: suvi – *Alca torda*.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-769.68048	0.03688	-20871	<2e-16 ***

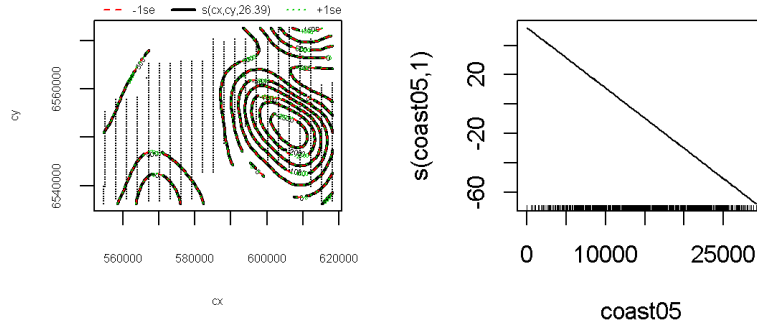
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	26.39	27.12	127201192	<2e-16 ***
s(coast05)	1.00	1.00	8253785	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.884 Deviance explained = 88.8%  
 GCV = 0.25293 Scale est. = 1.5723e-07 n = 1099



Joonis A.28: Tiheduspinna tunnused: suvi – *Alca torda*.

## Hahk *Somateria mollissima*

### Andmetabel

Tabel A.15: Andmetabel: suvi – hahk.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
37	suvi	95	37	1	163	9082	LL	1	1			618103	6541798
45	suvi	95	45	2	163	9084	LL	1	1			618076	6542960
47	suvi	95	47	2	432	9085	LL	1	1			618082	6543248
109	suvi	95	109	1	432	9102	LL	1	1			617977	6551902
397	suvi	95	397	18	163	8222	LL	1	1			611966	6543916
411	suvi	95	411	1	163	8226	LL	1	1			611979	6545754
4151	suvi	95	415	40	163	8227	LL	1	1			611973	6546270
416	suvi	95	416	50	163	8227	TV	2	1			611973	6546270
4171	suvi	95	417	80	163	8228	LL	1	1			611971	6546529
418	suvi	95	418	90	432	8228	TV	2	1			611971	6546529
4191	suvi	95	419	100	163	8228	LL	1	1			611969	6546789
4211	suvi	95	421	20	163	8229	LL	1	1			611966	6547045
4221	suvi	95	422	80	163	8229	TV	2	1			611966	6547045
423	suvi	95	423	40	163	8229	LL	1	1			611964	6547302
424	suvi	95	424	90	432	8229	TV	2	1			611964	6547302
425	suvi	95	425	20	432	8230	LL	1	1			611961	6547564
426	suvi	95	426	20	163	8230	TV	2	1			611961	6547564
427	suvi	95	427	7	163	8230	LL	1	1			611957	6547826
432	suvi	95	432	2	163	8231	TV	2	1			611966	6548342
437	suvi	95	437	80	432	8233	LL	1	1			611995	6549128
441	suvi	95	441	20	163	8234	LL	1	1			612000	6549654
442	suvi	95	442	1	432	8234	TV	2	1			612000	6549654
445	suvi	95	445	60	432	8235	LL	1	1			611973	6550186
450	suvi	95	450	60	432	8236	TV	2	1			611941	6550715
451	suvi	95	451	80	163	8236	LL	1	1			611938	6550975
452	suvi	95	452	20	163	8236	TV	2	1			611938	6550975
453	suvi	95	453	50	432	8237	LL	1	1			611947	6551231
454	suvi	95	454	10	432	8237	TV	2	1			611947	6551231
456	suvi	95	456	5	432	8237	TV	2	1			611959	6551490
476	suvi	95	476	9	163	8243	TV	2	1			611956	6554102
493	suvi	95	493	1	432	8247	LL	1	1			611988	6556445
725	suvi	95	725	18	432	7809	LL	1	1			609001	6553071
736	suvi	95	736	15	163	7806	TV	1	2			609010	6551772
738	suvi	95	738	20	432	7806	TV	1	2			609012	6551511
740	suvi	95	740	8	163	7805	TV	1	2			609012	6551252
741	suvi	95	741	20	163	7804	LL	1	2			609011	6550993
742	suvi	95	742	30	163	7804	TV	1	2			609011	6550993
743	suvi	95	743	30	432	7804	LL	1	2			609009	6550736
746	suvi	95	746	15	432	7803	TV	1	2			609009	6550482
747	suvi	95	747	20	432	7803	LL	1	2			609011	6550230
749	suvi	95	749	260	163	7802	LL	1	2			609011	6549977
7511	suvi	95	751	310	432	7802	LL	1	2			609011	6549719
752	suvi	95	752	40	163	7802	TV	1	2			609011	6549719
754	suvi	95	754	90	432	7801	TV	1	2			609013	6549461
760	suvi	95	760	35	163	7800	TV	1	2			609017	6548689
767	suvi	95	767	2	163	7798	LL	1	2			608998	6547662
820	suvi	95	820	1	163	7360	TV	2	1			605993	6544638
827	suvi	95	827	8	163	7362	LL	0	1			605969	6545674
828	suvi	95	828	1	163	7362	TV	2	1			605969	6545674
829	suvi	95	829	22	163	7362	LL	0	1			605967	6545923
8311	suvi	95	831	18	432	7363	LL	0	1			605971	6546172
833	suvi	95	833	20	163	7363	LL	0	1			605980	6546429
835	suvi	95	835	11	163	7364	LL	0	1			605988	6546689
842	suvi	95	842	15	163	7365	TV	2	1			606016	6547468
8431	suvi	95	843	40	432	7366	LL	0	1			606016	6547721
845	suvi	95	845	10	163	7366	LL	0	1			606010	6547976
847	suvi	95	847	31	432	7367	LL	0	1			606002	6548233
848	suvi	95	848	1	432	7367	TV	2	1			606002	6548233
849	suvi	95	849	12	163	7367	LL	0	1			605996	6548495
860	suvi	95	860	6	432	7370	TV	2	1			606022	6549808
878	suvi	95	878	7	163	7375	TV	2	1			605996	6552189
889	suvi	95	889	2	432	7378	LL	0	1			606036	6553770



2976	suvi	95	2976	200	432	2618	TV	2	1	572956	6549502
2977	suvi	95	2977	180	432	2617	LL	1	0	572954	6549235
2980	suvi	95	2980	20	163	2616	TV	2	1	572953	6548973
2982	suvi	95	2982	100	432	2616	TV	2	1	572953	6548712
29921	suvi	95	2992	70	432	2613	TV	2	1	572981	6547371
3000	suvi	95	3000	10	432	2611	TV	2	1	572978	6546303
3004	suvi	95	3004	15	432	2610	TV	2	1	572973	6545767
3006	suvi	95	3006	5	432	2610	TV	2	1	572973	6545501
3131	suvi	95	3131	7	163	2177	LL	0	1	569993	6545098
3137	suvi	95	3137	2	163	2178	LL	0	1	569997	6545908
3141	suvi	95	3141	1	432	2179	LL	0	1	569999	6546448
3143	suvi	95	3143	1	432	2180	LL	0	1	570002	6546713
3147	suvi	95	3147	8	432	2181	LL	0	1	570005	6547236
3148	suvi	95	3148	5	163	2181	TV	2	1	570005	6547236
3153	suvi	95	3153	1	432	2183	LL	0	1	570005	6548035
3167	suvi	95	3167	12	163	2186	LL	0	1	570008	6549899
3169	suvi	95	3169	26	163	2187	LL	0	1	570017	6550165
3171	suvi	95	3171	18	432	2187	LL	0	1	570017	6550436
3173	suvi	95	3173	6	432	2188	LL	0	1	570019	6550706
3174	suvi	95	3174	50	163	2188	TV	2	1	570019	6550706
3181	suvi	95	3181	4	163	2190	LL	0	1	570009	6551780
3183	suvi	95	3183	12	432	2191	LL	0	1	569998	6552046
3184	suvi	95	3184	25	163	2191	TV	2	1	569998	6552046
3226	suvi	95	3226	1	163	2202	TV	2	1	570006	6557681
3937	suvi	95	3937	20	432	463	LL	0	1	557966	6552086
3939	suvi	95	3939	30	1000	463	LL	0	1	557971	6552357
3941	suvi	95	3941	14	163	464	LL	0	1	557978	6552627
40681	suvi	95	4068	1	163	15	TV	2	2	554947	6544393

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim mc ds(\text{key} = \text{"hr"}, \text{formula} = \sim \text{size})$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object

Number of observations : 197  
Distance range : 0 - 1500  
AIC : 337.6922

Detection function:

Hazard-rate key function

Detection function parameters

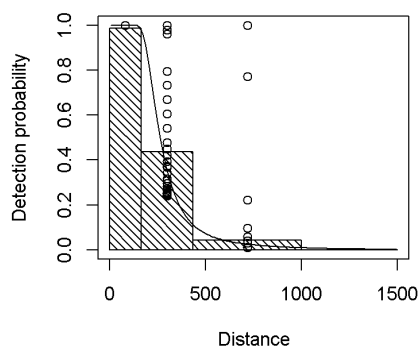
Scale Coefficients:

	estimate	se
(Intercept)	5.380022828	0.093481462
size	0.004296541	0.001082297

Shape parameters:

	estimate	se
(Intercept)	1.41844	0.1640125

	Estimate	SE	CV
Average p	0.2024828	0.01305588	0.06447893
N in covered region	972.9219913	88.70100915	0.09116970



Joonis A.29: Avastamisfunktsioon: suvi – **hahk** *Somateria mollissima*.

### Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Mudeli koond:

Family: quasipoisson

Link function: log

Formula:

$D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-16.6261	0.0585	-284.2	<2e-16 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

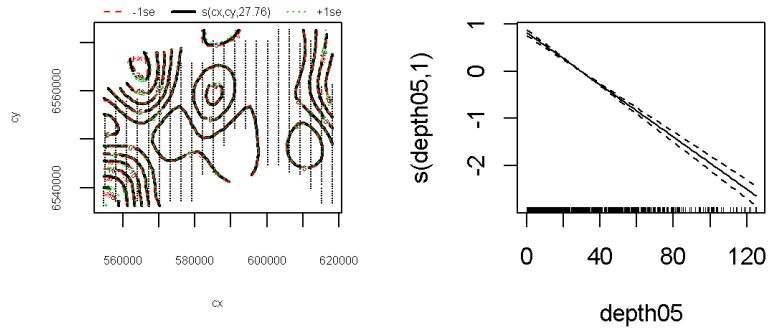
	edf	Ref.df	F	p-value
s(cx,cy)	27.76	28.74	3346.5	<2e-16 ***
s(depth05)	1.00	1.00	624.1	<2e-16 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.477 Deviance explained = 71%

GCV = 48.15 Scale est. = 0.5104 n = 1096



Joonis A.30: Tiheduspinna tunnused: suvi – **hahk** *Somateria mollissima*.







2223	sygis	35	2223	1	432	5234	LL	1	0	2	0	590996	6561615
2230	sygis	93	2230	25	432	5235	MN	1	0	2	0	590973	6562455
2247	sygis	256	2247	1	163	5240	LL	1	0	2	0	591020	6564963
2274	sygis	255	2274	1	163	5248	MN	1	0	2	0	591013	6568540
2276	sygis	255	2276	1	163	5248	MN	1	0	2	0	591007	6568808
2279	sygis	255	2279	8	163	5249	LL	1	0	2	0	591012	6569357
2281	sygis	255	2281	4	432	5250	LL	1	0	2	0	591010	6569624
2294	sygis	256	2294	1	163	5681	MN	1	0	2	0	594031	6569008
2297	sygis	255	2297	1	432	5679	LL	1	0	2	0	594034	6568425
2321	sygis	255	2321	1	163	5673	LL	1	0	2	0	594034	6565059
2324	sygis	269	2324	1	163	5672	MN	1	0	2	0	594034	6564778
2339	sygis	255	2339	1	163	5668	LL	1	0	2	0	594080	6562512
2344	sygis	255	2344	1	432	5666	MN	1	0	2	0	594071	6561977
2346	sygis	255	2346	1	163	5666	MN	1	0	2	0	594068	6561709
2357	sygis	255	2357	1	163	5663	LL	1	0	2	0	594056	6560063
2410	sygis	90	2410	20	1000	5648	MN	1	0	2	0	594093	6552865
2438	sygis	256	2438	1	1000	6085	MN	1	0	2	0	597019	6555227
2476	sygis	255	2476	1	432	6096	MN	1	0	2	0	596991	6560874
2489	sygis	255	2489	1	1000	6100	LL	1	0	1	0	596958	6562859
2490	sygis	256	2490	1	1000	6100	MN	1	0	2	0	596958	6562859
2499	sygis	255	2499	1	432	6103	LL	1	0	1	0	596949	6564295
2507	sygis	255	2507	1	432	6105	LL	1	0	1	0	596956	6565428
2508	sygis	255	2508	1	163	6105	MN	1	0	2	0	596956	6565428
2509	sygis	255	2509	1	163	6106	LL	1	0	1	0	596946	6565714
2529	sygis	255	2529	1	163	6112	LL	1	0	1	0	596953	6568602
2531	sygis	255	2531	1	1000	6112	LL	1	0	1	0	596951	6568891
2561	sygis	256	2561	1	1000	6541	LL	1	0	2	0	600018	6567198
2576	sygis	255	2576	1	163	6537	MN	1	0	2	0	599990	6565276
2656	sygis	255	2656	1	163	6516	MN	1	0	1	0	600015	6554507
2664	sygis	98	2664	2	163	6513	MN	1	0	1	0	599998	6553429
2698	sygis	256	2698	1	163	6504	MN	1	0	1	0	599983	6548779
2700	sygis	263	2700	1	163	6504	MN	1	0	1	0	599979	6548512
2733	sygis	87	2733	80	163	6928	LL	1	0	1	0	603034	6544871
2762	sygis	98	2762	80	1000	6936	MN	1	0	1	0	602952	6548956
2832	sygis	256	2832	1	432	6956	MN	1	0	1	0	602969	6558779
2852	sygis	255	2852	1	432	6962	MN	1	0	1	0	602979	6561543
2856	sygis	255	2856	1	432	6963	MN	1	0	1	0	602985	6562081
2864	sygis	258	2864	2	432	6965	MN	1	0	1	0	602983	6563209
2870	sygis	255	2870	1	1000	6967	MN	1	0	1	0	602982	6564083
2891	sygis	93	2891	800	163	6973	LL	1	0	2	0	602918	6567138
2892	sygis	256	2892	10	163	6973	MN	1	0	1	0	602918	6567138
2893	sygis	93	2893	2000	432	6901	LL	1	0	2	0	602885	6567418
2894	sygis	256	2894	15	163	6901	MN	1	0	1	0	602885	6567418
2895	sygis	93	2895	4000	1000	6902	LL	1	0	2	0	602872	6567702
2896	sygis	255	2896	100	163	6902	MN	1	0	1	0	602872	6567702
2898	sygis	255	2898	100	432	6902	MN	1	0	1	0	602874	6567991
2899	sygis	255	2899	20	163	6903	LL	1	0	2	0	602860	6568281
2900	sygis	255	2900	10	163	6903	MN	1	0	1	0	602860	6568281
2901	sygis	255	2901	100	432	6904	LL	1	0	2	0	602859	6568566
2902	sygis	255	2902	15	432	6904	MN	1	0	1	0	602859	6568566
2903	sygis	255	2903	20	1000	6904	LL	1	0	2	0	602882	6568840
2905	sygis	93	2905	1500	432	6977	LL	1	0	2	0	602914	6569117
2908	sygis	93	2908	6	163	6977	MN	1	0	1	0	602931	6569399
2909	sygis	93	2909	450	1000	6978	LL	1	0	2	0	602935	6569685
2992	sygis	93	2992	3000	432	7402	MN	1	0	2	0	606013	6565507
2999	sygis	93	2999	2500	1000	7399	LL	0	0	3	0	606027	6564467
3001	sygis	255	3001	200	432	7399	LL	0	0	3	0	606025	6564211
3015	sygis	255	3076	1	163	7395	MN	1	0	2	0	606016	6562484
3102	sygis	255	3163	2	163	7372	LL	0	0	3	0	606014	6550786

## Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{mc}(\text{key} = \text{"hn"}, \text{formula} = \sim \text{obs} + \text{wav})$

Valitud avastamisfunktsioon: half-normal key function

Mudeli koond:

Summary for ds object

Number of observations : 125  
Distance range : 0 - 1500  
AIC : 240.6744

Detection function:

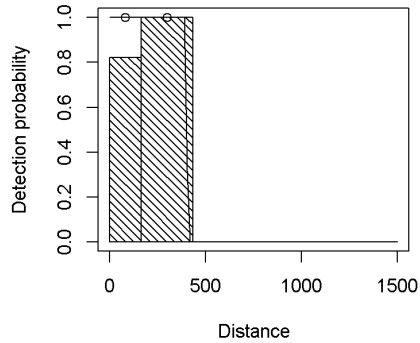
Half-normal key function

Detection function parameters

Scale Coefficients:

	estimate	se
(Intercept)	5.6425217	0.1794100
obsMN	0.3191362	0.1460263
wav2	-0.2655009	0.2009081
wav3	-0.4691620	0.2027193

	Estimate	SE	CV
Average p	0.2037179	0.0142785	0.07008957
N in covered region	613.5937037	65.4627408	0.10668744



Joonis A.31: Avastamisfunktsioon: sügis – kõik liigid.

### Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy)$   
 Mudeli koond:

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-16.03379	0.00223	-7190	<2e-16 ***

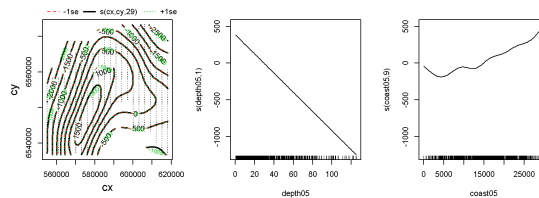
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	27.48	28.76	533637	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.114 Deviance explained = 51.9%  
 GCV = 20.129 Scale est. = 0.00065922 n = 881



Joonis A.32: Tiheduspinna tunnused: sügis – kõik liigid.

### Sukelpardid

### Andmetabel

Tabel A.17: Andmetabel: sügis – sukelpardid.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y	
59	sygis	93	59	40	432	16	LL	0	0	3	0	554934	6544836
139	sygis	93	139	5	163	474	LL	0	0	3	0	558011	6557570
161	sygis	93	161	18	163	468	LL	0	0	3	0	557983	6554541
165	sygis	93	165	2	432	466	LL	0	0	3	0	557988	6553998
169	sygis	93	169	4	163	465	LL	0	0	3	0	557988	6553462
299	sygis	93	299	1	163	866	LL	1	0	3	0	561105	6537546
367	sygis	93	367	45	432	885	LL	1	0	3	0	560987	6547163
415	sygis	93	415	4	163	898	LL	1	0	3	0	560983	6553813
417	sygis	93	417	12	432	899	LL	1	0	3	0	560980	6554088
419	sygis	93	419	4	163	899	LL	1	0	3	0	560976	6554362
421	sygis	93	421	240	432	900	LL	1	0	3	0	560969	6554633
533	sygis	93	533	2	163	1316	LL	1	1	3	0	564016	6546892
578	sygis	93	578	25	163	1305	MN	1	0	3	0	564002	6541139
612	sygis	93	612	3	163	1730	MN	1	0	2	0	567014	6537563
627	sygis	93	627	25	163	1734	LL	1	0	2	0	566992	6539863
737	sygis	93	737	4	163	1765	LL	1	0	3	0	566969	6555480
739	sygis	93	739	6	432	1766	LL	1	0	3	0	566974	6555763
761	sygis	93	761	2	163	1772	LL	1	0	3	0	566977	6558868
822	sygis	93	822	2	163	2207	LL	1	1	3	0	570026	6560486
882	sygis	99	882	18	432	2192	LL	1	1	2	0	570013	6552530
906	sygis	93	906	18	163	2185	LL	1	1	2	0	570001	6549311
982	sygis	93	982	18	432	2165	LL	1	1	2	0	570009	6539022
1180	sygis	93	1180	2	163	2642	LL	1	0	3	0	572975	6561998
1232	sygis	93	1232	80	432	3075	LL	1	0	3	0	575990	6562002
1234	sygis	93	1234	20	432	3074	LL	1	0	3	0	575986	6561734
1431	sygis	90	1431	15	432	3460	MN	1	0	2	0	579000	6538565
1444	sygis	93	1444	200	432	3464	LL	1	0	1	0	578967	6540604
1446	sygis	93	1446	90	432	3464	LL	1	0	1	0	578966	6540893
1449	sygis	93	1449	60	432	3465	MN	1	0	2	0	578966	6541188
1451	sygis	93	1451	1	163	3465	MN	1	0	2	0	578967	6541477
1614	sygis	93	1614	20	163	3510	LL	1	0	3	0	578993	6563752
1813	sygis	105	1813	6	163	4336	MN	1	0	3	0	584998	6544926
1822	sygis	93	1822	350	1000	4339	LL	1	0	1	0	584989	6546341
2134	sygis	93	2134	30	1000	4782	LL	1	0	1	0	588087	6551552
2181	sygis	93	2181	120	432	5222	LL	1	0	2	0	590970	6555827
2183	sygis	93	2183	40	163	5223	LL	1	0	2	0	590971	6556100
2185	sygis	93	2185	80	1000	5223	LL	1	0	2	0	590982	6556371
2230	sygis	93	2230	25	432	5235	MN	1	0	2	0	590973	6562455
2410	sygis	90	2410	20	1000	5648	MN	1	0	2	0	594093	6552865
2664	sygis	98	2664	2	163	6513	MN	1	0	1	0	599998	6553429
2733	sygis	87	2733	80	163	6928	LL	1	0	1	0	603034	6544871
2762	sygis	98	2762	80	1000	6936	MN	1	0	1	0	602952	6548956
2891	sygis	93	2891	800	163	6973	LL	1	0	2	0	602918	6567138
2893	sygis	93	2893	2000	432	6901	LL	1	0	2	0	602885	6567418
2895	sygis	93	2895	4000	1000	6902	LL	1	0	2	0	602872	6567702
2905	sygis	93	2905	1500	432	6977	LL	1	0	2	0	602914	6569117
2908	sygis	93	2908	6	163	6977	MN	1	0	1	0	602931	6569399
2909	sygis	93	2909	450	1000	6978	LL	1	0	2	0	602935	6569685
2992	sygis	93	2992	3000	432	7402	MN	1	0	2	0	606013	6565507
2999	sygis	93	2999	2500	1000	7399	LL	0	0	3	0	606027	6564467

## Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{mc}ds(\text{key} = \text{"hn"}, \text{formula} = \sim \text{wav})$

Valitud avastamisfunktsioon: half-normal key function

Mudeli koond:

Summary for ds object

Number of observations : 50  
 Distance range : 0 - 1500  
 AIC : 101.7787

Detection function:

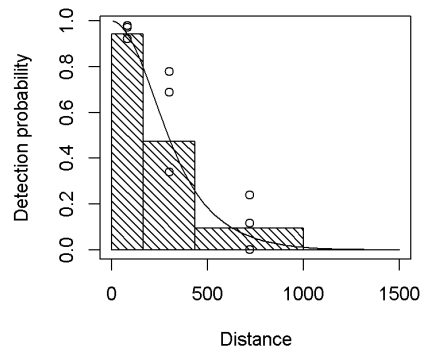
Half-normal key function

Detection function parameters

Scale Coefficients:

	estimate	se
(Intercept)	6.0497374	0.3518151
wav2	-0.2007196	0.4110250
wav3	-0.7333168	0.3850033

	Estimate	SE	CV
Average p	0.223904	0.02770069	0.1237168
N in covered region	223.309957	39.47673127	0.1767800



Joonis A.33: Avastamisfunktsioon: sügis – sukelpardid.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-1.423e+01	5.181e-04	-27459	<2e-16 ***

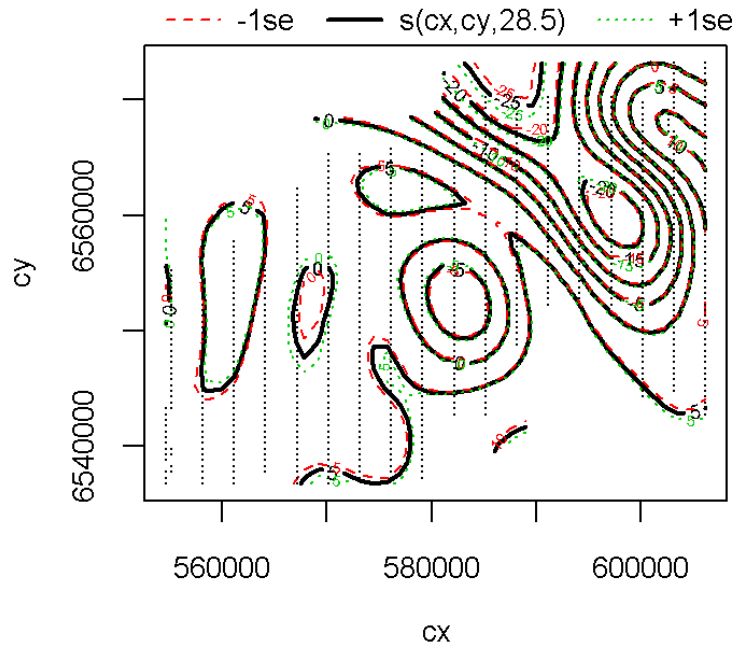
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	24.868	27.603	13523549	<2e-16 ***
s(depth05)	1.277	1.485	26993698	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.307 Deviance explained = 71.1%  
 GCV = 242.61 Scale est. = 0.00041356 n = 880



Joonis A.34: Tiheduspinna tunnused: sügis – sukelpardid.

## Hõbekajakas *Larus argentatus*

### Andmetabel

Tabel A.18: Andmetabel: sügis – hõbekajakas.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
107	sygis	256	107	1	163	29	LL	0	0	3	0	554925	6551361
115	sygis	256	115	1	432	31	LL	0	0	3	0	554939	6552449
239	sygis	256	239	1	432	447	LL	0	0	3	0	558033	6544171
302	sygis	256	302	1	1000	866	MN	1	0	3	0	561096	6537843
333	sygis	256	333	1	163	875	LL	1	0	3	0	560985	6542435
399	sygis	256	399	1	432	894	LL	1	0	3	0	560977	6551581
488	sygis	256	488	1	432	1328	MN	1	0	3	0	563981	6552839
509	sygis	256	509	1	432	1322	LL	1	1	3	0	563993	6549993
534	sygis	256	534	1	1000	1316	MN	1	0	3	0	564016	6546892
622	sygis	256	622	1	432	1732	MN	1	0	2	0	566999	6538994
626	sygis	256	626	1	432	1734	MN	1	0	2	0	566992	6539571
628	sygis	256	628	1	163	1734	MN	1	0	2	0	566992	6539863
634	sygis	256	634	1	163	1736	MN	1	0	2	0	566994	6540748
656	sygis	256	656	1	163	1742	MN	1	0	2	0	566981	6543936
664	sygis	256	664	1	432	1745	MN	1	0	2	0	566992	6545094
674	sygis	256	674	1	432	1748	MN	1	0	2	0	566982	6546518
730	sygis	256	730	1	432	1763	MN	1	0	2	0	566950	6554354
791	sygis	256	791	1	163	2216	MN	1	0	3	0	569982	6564828
813	sygis	256	813	1	432	2210	MN	1	0	3	0	570026	6561885
831	sygis	256	831	1	432	2205	MN	1	0	3	0	570013	6559430
937	sygis	256	937	1	163	2177	MN	1	0	3	0	570013	6545220
1025	sygis	256	1025	1	1000	2600	MN	1	0	2	0	572960	6540589
1065	sygis	256	1065	1	432	2611	MN	1	0	2	0	572953	6546151
1067	sygis	256	1067	1	1000	2611	MN	1	0	2	0	572956	6546424
1196	sygis	256	1196	1	1000	2647	LL	1	0	3	0	572987	6564229
1227	sygis	256	1227	1	1000	3076	MN	1	0	2	0	576003	6562803
1243	sygis	256	1243	1	1000	3072	MN	1	0	2	0	576013	6560663
1259	sygis	256	1259	1	432	3068	MN	1	0	2	0	575987	6558520
1261	sygis	256	1261	1	1000	3067	MN	1	0	2	0	575976	6558256
1433	sygis	256	1433	1	432	3460	MN	1	0	2	0	579012	6538848
1496	sygis	256	1496	1	432	3478	LL	1	0	2	0	578994	6547809
1606	sygis	256	1606	1	432	3508	LL	1	0	3	0	579004	6562662
1611	sygis	256	1611	1	163	3509	MN	1	0	2	0	579006	6563199
1669	sygis	256	1669	1	432	3934	MN	1	0	3	0	582037	6559993
1829	sygis	256	1829	1	432	4341	MN	1	0	3	0	584995	6547173
1839	sygis	256	1839	2	432	4344	MN	1	0	3	0	584958	6548611
1853	sygis	256	1853	1	1000	4348	MN	1	0	3	0	584991	6550526

1900	sygis	256	1900	1	163	4361	LL	1	0	2	0	584991	6557114
1968	sygis	256	1968	1	1000	4380	LL	1	0	3	0	584961	6566541
1969	sygis	256	1969	1	163	4380	MN	1	0	2	0	584961	6566541
2049	sygis	256	2049	1	1000	4804	MN	1	0	2	0	588043	6562956
2067	sygis	256	2067	1	163	4800	MN	1	0	2	0	588009	6560528
2091	sygis	256	2091	1	1000	4793	MN	1	0	2	0	588041	6557329
2095	sygis	256	2095	1	1000	4792	MN	1	0	2	0	588031	6556787
2108	sygis	256	2108	1	1000	4788	LL	1	0	2	0	588072	6554962
2109	sygis	256	2109	1	163	4788	MN	1	0	2	0	588072	6554962
2111	sygis	256	2111	3	432	4788	MN	1	0	2	0	588065	6554698
2113	sygis	256	2113	5	1000	4787	MN	1	0	2	0	588057	6554434
2115	sygis	256	2115	1	432	4787	MN	1	0	2	0	588053	6554171
2247	sygis	256	2247	1	163	5240	LL	1	0	2	0	591020	6564963
2294	sygis	256	2294	1	163	5681	MN	1	0	2	0	594031	6569008
2438	sygis	256	2438	1	1000	6085	MN	1	0	2	0	597019	6555227
2490	sygis	256	2490	1	1000	6100	MN	1	0	2	0	596958	6562859
2561	sygis	256	2561	1	1000	6541	LL	1	0	2	0	600018	6567198
2698	sygis	256	2698	1	163	6504	MN	1	0	1	0	599983	6548779
2832	sygis	256	2832	1	432	6956	MN	1	0	1	0	602969	6558779
2892	sygis	256	2892	10	163	6973	MN	1	0	1	0	602918	6567138
2894	sygis	256	2894	15	163	6901	MN	1	0	1	0	602885	6567418

## Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{mcfs}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{wav})$

Valitud avastamisfunktsioon: hazard-rate key function

Mudeli koond:

Summary for ds object

Number of observations : 58  
Distance range : 0 - 1500  
AIC : 128.2183

Detection function:

Hazard-rate key function

Detection function parameters

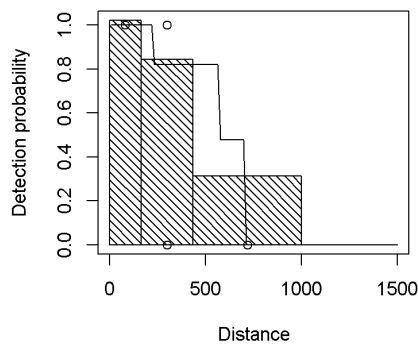
Scale Coefficients:

	estimate	se
(Intercept)	5.3894484	NaN
wav2	1.1664819	0.1035972
wav3	0.9647506	NaN

Shape parameters:

	estimate	se
(Intercept)	11.29988	555.5046

	Estimate	SE	CV
Average p	0.3813578	0.0299256	0.07847118
N in covered region	152.0881409	20.0847509	0.13205994



Joonis A.35: Avastamisfunktsioon: sügis – hõbekajakas *Larus argentatus*.



## Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(depth05, k = 4) + s(coast05, k = 4)$

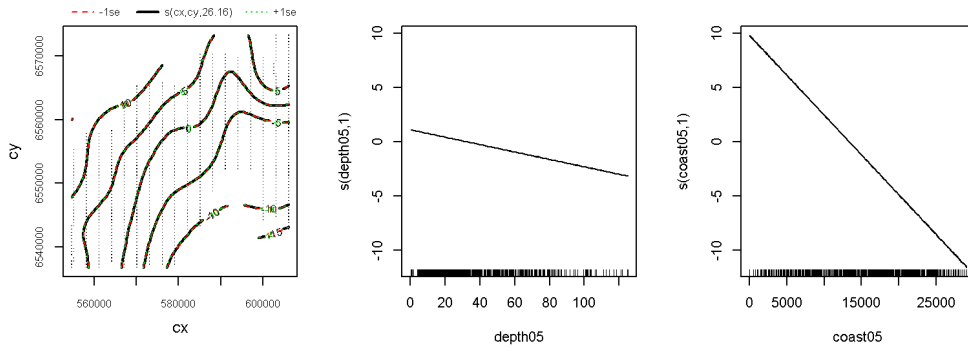
Parametric coefficients:  
 Estimate Std. Error t value Pr(>|t|)  
 (Intercept) -1.671e+01 7.018e-04 -23812 <2e-16 \*\*\*  
 ---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  
 edf Ref.df F p-value  
 s(cx,cy) 26.16 28.4 1032160 <2e-16 \*\*\*  
 s(depth05) 1.00 1.0 1175919 <2e-16 \*\*\*  
 s(coast05) 1.00 1.0 284631 <2e-16 \*\*\*  
 ---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.261 Deviance explained = 45.5%  
 GCV = 1.752 Scale est. = 2.9604e-05 n = 880



Joonis A.36: Tiheduspinna tunnused: sügis – hõbekajakas *Larus argentatus*.

## Kalakajakas *Larus canus*

### Andmetabel

Tabel A.19: Andmetabel: sügis – kalakajakas.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y	
23	sygis	255	23	1	163	9197	LL	0	0	3	0	554900	6539878
99	sygis	255	99	1	432	27	LL	0	0	3	0	554931	6550255
105	sygis	255	105	1	163	29	LL	0	0	3	0	554922	6551081
118	sygis	255	118	1	163	32	MN	1	0	3	0	554940	6552720
156	sygis	255	156	1	1000	469	MN	1	0	3	0	557998	6555353
317	sygis	255	317	1	163	871	LL	1	0	3	0	561028	6540164
362	sygis	255	362	1	432	883	MN	1	0	3	0	560981	6546322
381	sygis	255	381	1	163	889	LL	1	0	3	0	560971	6549093
422	sygis	255	422	1	163	900	MN	1	0	3	0	560969	6554633
490	sygis	255	490	1	163	1328	MN	1	0	3	0	563972	6552576
521	sygis	255	521	1	163	1319	LL	1	1	3	0	564031	6548463
528	sygis	255	528	1	432	1318	MN	1	0	3	0	564027	6547679
531	sygis	255	531	1	432	1317	LL	1	1	3	0	564011	6547158
550	sygis	255	550	1	432	1312	MN	1	0	3	0	564013	6544798
580	sygis	255	580	1	163	1304	MN	1	0	3	0	564007	6540871
610	sygis	255	610	1	163	1729	MN	1	0	2	0	567004	6537279
613	sygis	255	613	1	163	1730	LL	1	0	2	0	567008	6537849



### Avastamisfunktsioon

**Mudeli võrrand:**  $\sim$  mcds(key = "hn", formula =  $\sim$  obs + wav)

**Valitud avastamisfunktsioon:** half-normal key function

**Mudeli koond:**

Summary for ds object

Number of observations : 125  
 Distance range : 0 - 1500  
 AIC : 240.6744

Detection function:

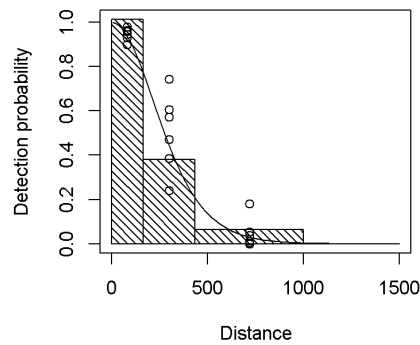
Half-normal key function

Detection function parameters

Scale Coefficients:

	estimate	se
(Intercept)	5.6425217	0.1794100
obsMN	0.3191362	0.1460263
wav2	-0.2655009	0.2009081
wav3	-0.4691620	0.2027193

	Estimate	SE	CV
Average p	0.2037179	0.0142785	0.07008957
N in covered region	613.5937037	65.4627408	0.10668744



Joonis A.37: Avastamisfunktsioon: sügis – **kalakajakas** *Larus canus*.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy)$

**Mudeli koond:**

Family: quasipoisson

Link function: log

Formula:

$D \sim s(cx, cy)$

Parametric coefficients:

Estimate	Std. Error	t value	Pr(> t )
----------	------------	---------	----------

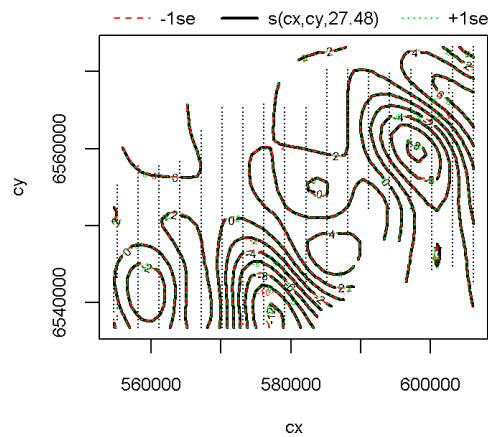
```

(Intercept) -16.03379    0.00223   -7190   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
      edf Ref.df      F p-value
s(cx,cy) 27.48  28.76 533637 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.114  Deviance explained = 51.9%
GCV = 20.129  Scale est. = 0.00065922  n = 881

```



Joonis A.38: Tiheduspinna tunnused: sügis – kalakajakas *Larus canus*.

## *Aul Clangula hyemalis*

### Andmetabel

Tabel A.20: Andmetabel: sügis – aul.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
59	sygis	93	59	40	432	16	LL	0	0	3	0	554934	6544836
139	sygis	93	139	5	163	474	LL	0	0	3	0	558011	6557570
161	sygis	93	161	18	163	468	LL	0	0	3	0	557983	6554541
165	sygis	93	165	2	432	466	LL	0	0	3	0	557988	6553998
169	sygis	93	169	4	163	465	LL	0	0	3	0	557988	6553462
299	sygis	93	299	1	163	866	LL	1	0	3	0	561105	6537546
367	sygis	93	367	45	432	885	LL	1	0	3	0	560987	6547163
415	sygis	93	415	4	163	898	LL	1	0	3	0	560983	6553813
417	sygis	93	417	12	432	899	LL	1	0	3	0	560980	6554088
419	sygis	93	419	4	163	899	LL	1	0	3	0	560976	6554362
421	sygis	93	421	240	432	900	LL	1	0	3	0	560969	6554633
533	sygis	93	533	2	163	1316	LL	1	1	3	0	564016	6546892
578	sygis	93	578	25	163	1305	MN	1	0	3	0	564002	6541139
612	sygis	93	612	3	163	1730	MN	1	0	2	0	567014	6537563
627	sygis	93	627	25	163	1734	LL	1	0	2	0	566992	6539863
737	sygis	93	737	4	163	1765	LL	1	0	3	0	566969	6555480
739	sygis	93	739	6	432	1766	LL	1	0	3	0	566974	6555763
761	sygis	93	761	2	163	1772	LL	1	0	3	0	566977	6558868
822	sygis	93	822	2	163	2207	LL	1	1	3	0	570026	6560486
906	sygis	93	906	18	163	2185	LL	1	1	2	0	570001	6549311
982	sygis	93	982	18	432	2165	LL	1	1	2	0	570009	6539022
1180	sygis	93	1180	2	163	2642	LL	1	0	3	0	572975	6561998
1232	sygis	93	1232	80	432	3075	LL	1	0	3	0	575990	6562002
1234	sygis	93	1234	20	432	3074	LL	1	0	3	0	575986	6561734
1444	sygis	93	1444	200	432	3464	LL	1	0	1	0	578967	6540604
1446	sygis	93	1446	90	432	3464	LL	1	0	1	0	578966	6540893
1449	sygis	93	1449	60	432	3465	MN	1	0	2	0	578966	6541188
1451	sygis	93	1451	1	163	3465	MN	1	0	2	0	578967	6541477
1614	sygis	93	1614	20	163	3510	LL	1	0	3	0	578993	6563752
1822	sygis	93	1822	350	1000	4339	LL	1	0	1	0	584989	6546341
2134	sygis	93	2134	30	1000	4782	LL	1	0	1	0	588087	6551552
2181	sygis	93	2181	120	432	5222	LL	1	0	2	0	590970	6555827

2183	sygis	93	2183	40	163	5223	LL	1	0	2	0	590971	6556100
2185	sygis	93	2185	80	1000	5223	LL	1	0	2	0	590982	6556371
2230	sygis	93	2230	25	432	5235	MN	1	0	2	0	590973	6562455
2891	sygis	93	2891	800	163	6973	LL	1	0	2	0	602918	6567138
2893	sygis	93	2893	2000	432	6901	LL	1	0	2	0	602885	6567418
2895	sygis	93	2895	4000	1000	6902	LL	1	0	2	0	602872	6567702
2905	sygis	93	2905	1500	432	6977	LL	1	0	2	0	602914	6569117
2908	sygis	93	2908	6	163	6977	MN	1	0	1	0	602931	6569399
2909	sygis	93	2909	450	1000	6978	LL	1	0	2	0	602935	6569685
2992	sygis	93	2992	3000	432	7402	MN	1	0	2	0	606013	6565507
2999	sygis	93	2999	2500	1000	7399	LL	0	0	3	0	606027	6564467

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim$  mcds(key = "hn", formula =  $\sim$  obs + wav)

**Valitud avastamisfunktsioon:** half-normal key function

**Mudeli koond:**

Summary for ds object

Number of observations : 43  
 Distance range : 0 - 1500  
 AIC : 85.30188

Detection function:

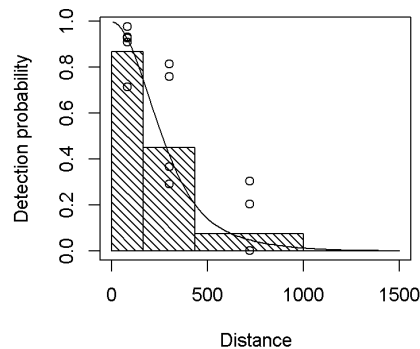
Half-normal key function

Detection function parameters

Scale Coefficients:

	estimate	se
(Intercept)	6.1436493	0.5641580
obsMN	-0.7481136	0.5378435
wav2	-0.1457430	0.6131271
wav3	-0.7907008	0.5883534

	Estimate	SE	CV
Average p	0.203989	0.03313164	0.1624188
N in covered region	210.795706	44.99841736	0.2134693



Joonis A.39: Avastamisfunktsioon: sügis – **aul** *Clangula hyemalis*.

## Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy)$

**Mudeli koond:**

Family: quasipoisson

Link function: log

Formula:  
D ~ s(cx, cy)

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-58.133	1.288	-45.15	<2e-16 ***

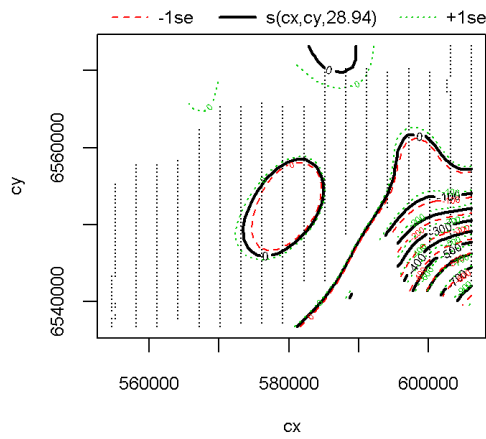
---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	28.81	28.99	489.4	<2e-16 ***

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.306 Deviance explained = 74.6%  
GCV = 236.69 Scale est. = 9.4324 n = 881



Joonis A.40: Tiheduspinna tunnused: sügis – **aul** *Clangula hyemalis*.













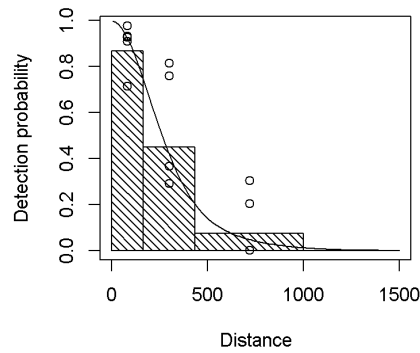


Detection function parameters

Scale Coefficients:

	estimate	se
(Intercept)	6.1436493	0.5641580
obsMN	-0.7481136	0.5378435
wav2	-0.1457430	0.6131271
wav3	-0.7907008	0.5883534

	Estimate	SE	CV
Average p	0.203989	0.03313164	0.1624188
N in covered region	210.795706	44.99841736	0.2134693



Joonis A.41: Avastamisfunktsioon: talv – kõik liigid.

**Tiheduspind**

**Mudeli võrrand:**  $D \sim s(cx, cy)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-58.133	1.288	-45.15	<2e-16 ***

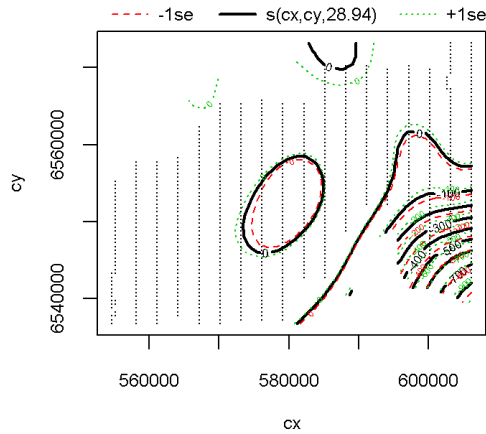
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	28.81	28.99	489.4	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.306    Deviance explained = 74.6%  
 GCV = 236.69    Scale est. = 9.4324    n = 881



Joonis A.42: Tiheduspinna tunnused: talv – kõik liigid.

## Sukelpardid

### Andmetabel

Tabel A.22: Andmetabel: talv – sukelpardid.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
3177	talv	105	18100	2	432	9074	TV/HP	1	0	0	2	618159	6537926
3185	talv	93	26100	20	432	9076	TV/HP	1	0	0	2	618160	6538564
3207	talv	93	48100	60	1000	9079	TV/HP	1	0	0	2	618173	6540300
3237	talv	105	78100	4	163	9084	TV/HP	1	0	0	2	618111	6542681
3243	talv	90	8410	10	163	9085	TV/HP	1	0	0	2	618109	6543151
3471	talv	93	34410	1	163	8689	TV/HP	2	0	1	2	614966	6561013
3720	talv	105	59310	8	432	8649	LL	2	0	1	1	614981	6541029
3771	talv	90	6445	2	163	9587	TV/HP	2	0	1	1	614939	6536992
3780	talv	90	6911	24	163	8216	LL	2	0	0	1	612024	6540612
3784	talv	90	6951	32	432	8216	LL	2	0	0	1	612017	6540922
3795	talv	105	70610	10	1000	8218	TV/HP	2	0	0	1	611987	6541666
3802	talv	90	71310	8	432	8219	LL	2	0	0	0	611984	6542259
3810	talv	90	72110	8	432	8220	LL	2	0	0	0	611985	6542847
3814	talv	90	7251	6	163	8221	LL	2	0	0	0	611987	6543143
3816	talv	90	7271	2	432	8221	LL	2	0	0	0	611993	6543291
3818	talv	90	7291	20	432	8221	LL	2	0	0	0	611999	6543439
3820	talv	93	73110	200	432	8222	LL	2	0	0	0	612002	6543590
3822	talv	93	73310	400	432	8222	LL	2	0	0	0	612004	6543740
3824	talv	93	73510	200	163	8222	LL	2	0	0	0	612011	6543941
3826	talv	90	73710	20	432	8223	LL	2	0	0	0	612017	6544093
3830	talv	90	74110	20	163	8223	LL	2	0	0	0	612025	6544396
3832	talv	90	74310	2	163	8224	LL	2	0	0	0	612028	6544549
3833	talv	90	74410	200	432	8224	TV/HP	2	0	1	0	612028	6544549
3834	talv	90	74510	4	163	8224	LL	2	0	0	0	612030	6544701
3835	talv	93	74610	50	432	8224	TV/HP	2	0	0	0	612030	6544701
3836	talv	90	74710	8	163	8224	LL	2	0	0	0	612031	6544853
3838	talv	105	74910	8	163	8225	LL	2	0	0	0	612033	6545006
3839	talv	90	75010	70	163	8225	TV/HP	2	0	1	0	612033	6545006
3842	talv	90	75310	20	432	8225	LL	2	0	0	0	612034	6545311
3843	talv	90	75410	80	432	8225	TV/HP	2	0	1	0	612034	6545311
3844	talv	90	75510	4	432	8225	LL	2	0	0	0	612034	6545465
3846	talv	90	7571	2	432	8226	LL	2	0	0	0	612035	6545620
3849	talv	93	7601	120	432	8226	TV/HP	2	0	0	0	612035	6545774
3851	talv	105	7621	20	432	8226	TV/HP	2	0	0	0	612033	6545929
3852	talv	105	7631	2	432	8227	LL	2	0	0	0	612028	6546084
3855	talv	93	76610	50	1000	8227	TV/HP	2	0	0	0	612022	6546239
3871	talv	90	78210	6	432	8229	TV/HP	2	0	1	2	611980	6547499
3881	talv	93	7921	10	432	8231	TV/HP	2	0	0	2	611975	6548286
3894	talv	90	80510	1	163	8233	LL	2	0	0	0	611977	6549387
4109	talv	93	10201	6	163	8267	TV/HP	2	0	1	0	611951	6566412
4404	talv	93	13471	120	432	7804	LL	2	1	0	0	608977	6550955
4427	talv	93	13701	9	432	7801	TV/HP	2	1	0	0	608991	6549217
4462	talv	93	14051	2	432	7795	LL	2	1	0	0	608999	6546388
4481	talv	93	14241	2	163	7792	TV/HP	2	1	0	0	608967	6544984
4482	talv	93	14251	320	432	7792	LL	2	1	0	0	608965	6544828
4484	talv	93	14271	110	1000	7792	LL	2	1	0	0	608966	6544670
4490	talv	93	14331	120	1000	7791	LL	2	1	0	0	608966	6544199
4520	talv	93	15191	4	163	7359	LL	2	0	0	0	605999	6544130
4530	talv	93	15291	2	432	7360	LL	2	0	0	0	605980	6544953
4563	talv	93	15621	3	432	7366	TV/HP	2	0	1	0	606020	6547524
4564	talv	105	15631	2	432	7366	LL	2	0	0	0	606012	6547689
4568	talv	93	15671	2	163	7367	LL	2	0	0	0	605996	6548020
4630	talv	93	16291	1	432	7377	LL	2	0	0	0	605979	6553210
4763	talv	93	17621	2	163	7397	TV/HP	2	0	1	0	606057	6563441
4857	talv	93	18561	3	432	7412	TV/HP	2	0	1	0	605966	6570634







## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{mcdfs}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{sun})$   
**Valitud avastamisfunktsioon:** hazard-rate key function  
**Mudeli koond:**

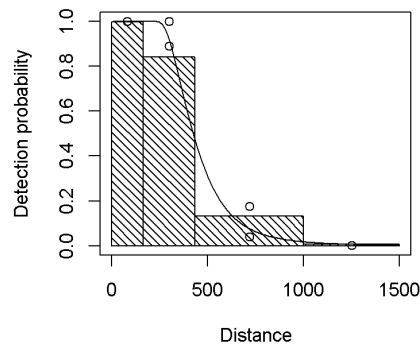
Summary for ds object  
Number of observations : 263  
Distance range : 0 - 1500  
AIC : 545.9028

Detection function:  
Hazard-rate key function

Detection function parameters  
Scale Coefficients:  
estimate se  
(Intercept) 5.8742787 0.1089842  
sun1 0.3364922 0.1141792

Shape parameters:  
estimate se  
(Intercept) 1.50559 0.1681639

	Estimate	SE	CV
Average p	0.3116149	0.01996869	0.06408131
N in covered region	843.9904226	69.35906354	0.08217992



Joonis A.43: Avastamisfunktsioon: talv – sukelpardid.

## Tiheduspind

**Mudeli võrrand:**  $D \sim s(\text{cx}, \text{cy}) + s(\text{depth05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(\text{cx}, \text{cy}) + s(\text{depth05}, k = 4)$

Parametric coefficients:  
Estimate Std. Error t value Pr(>|t|)  
(Intercept) -13.53620 0.09128 -148.3 <2e-16 \*\*\*

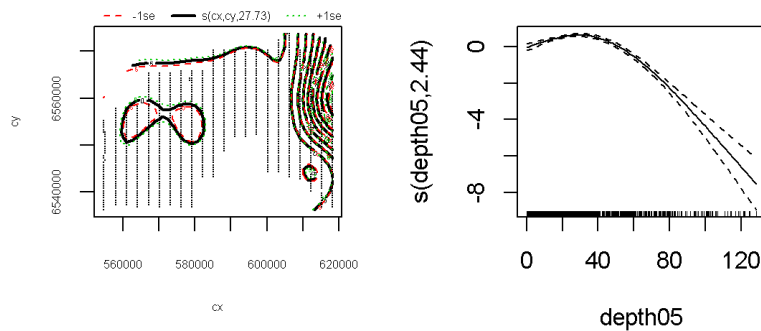
```

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
      edf Ref.df    F p-value
s(cx,cy) 27.730 28.685 226.1 <2e-16 ***
s(depth05) 2.438  2.782 132.2 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.111  Deviance explained = 36.8%
GCV = 190.17  Scale est. = 12.072    n = 1106

```



Joonis A.44: Tiheduspinna tunnused: talv – sukelpardid.

## Vaerad

### Andmetabel

Tabel A.23: Andmetabel: talv – vaerad.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y	
5150	talv	98	21771	8	432	6944	LL	2	1	1	0	602963	6552606
5376	talv	98	24781	24	432	6514	LL	2	0	0	0	599970	6553995
5776	talv	98	29561	8	432	6085	LL	2	1	0	0	597008	6555062
5780	talv	98	29601	20	1000	6084	LL	2	1	0	0	597012	6554746
5782	talv	98	29621	10	163	6084	LL	2	1	0	0	597016	6554590
5786	talv	98	29661	120	432	6083	LL	2	1	0	0	597023	6554272
6856	talv	98	4381	40	432	4340	LL	2	1	0	0	585029	6546840
6920	talv	98	4526	25	432	3902	LL	2	0	0	0	582011	6543953
6934	talv	98	4540	1	163	3905	LL	2	0	0	0	582013	6545018
6978	talv	98	4584	5	432	3911	LL	2	0	1	0	582029	6548413
7506	talv	98	5112	18	1000	3463	LL	2	1	0	0	578929	6540464
7755	talv	99	5433	15	432	3056	TV/HP	2	0	1	0	575993	6552935
7962	talv	99	5721	6	432	2641	LL	2	1	1	0	572967	6561300

### Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{mcfs}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{sun})$

Valitud avastamisfunktsioon: hazard-rate key function

Mudeli koond:

```

Summary for ds object
Number of observations : 13
Distance range         : 0 - 1500
AIC                    : 27.53934

```

```

Detection function:
Hazard-rate key function

```

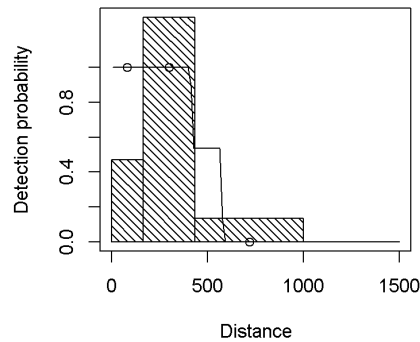
Detection function parameters  
 Scale Coefficients:

	estimate	se
(Intercept)	6.024022	16.016641
sun1	0.328672	1.461675

Shape parameters:

	estimate	se
(Intercept)	5.400865	6108.449

	Estimate	SE	CV
Average p	0.333738	0.2150608	0.6443999
N in covered region	38.952710	26.6239492	0.6834942



Joonis A.45: Avastamisfunktsioon: talv – vaerad.

## Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-1.121e+03	4.347e-02	-25779	<2e-16 ***

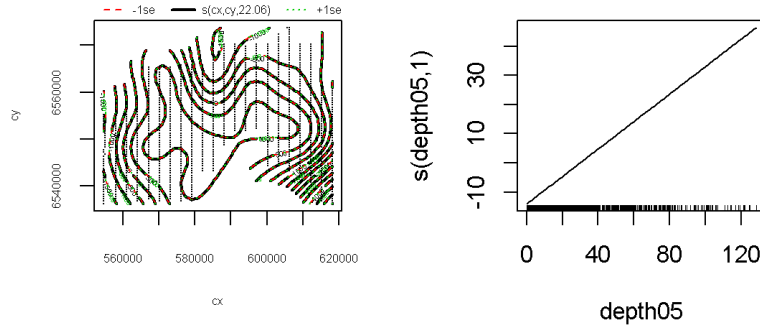
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	22.06	23.25	256084859	<2e-16 ***
s(depth05)	1.00	1.00	178137522	<2e-16 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.936 Deviance explained = 94.5%  
 GCV = 0.52102 Scale est. = 3.0324e-07 n = 1106



Joonis A.46: Tiheduspinna tunnused: talv – vaerad.

## Kaurid

### Andmetabel

Tabel A.24: Andmetabel: talv – kaurid.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y	
5135	talv	1	21621	1	432	6946	TV/HP	2	0	1	0	602984	6553892
5148	talv	1	21751	2	1000	6944	LL	2	1	1	0	602961	6552768
5421	talv	2	25231	2	432	6521	TV/HP	2	0	1	0	599973	6557437
5751	talv	1	29311	4	432	6089	TV/HP	2	0	0	0	596987	6557121
5866	talv	1	31211	1	432	5654	LL	2	0	1	0	594085	6555818
5877	talv	1	31321	2	163	5656	TV/HP	2	0	1	0	594070	6556576
5887	talv	1	31421	2	432	5657	TV/HP	2	0	1	0	594083	6557338
5971	talv	1	3226	1	432	5670	TV/HP	2	0	1	0	594025	6563729
6140	talv	1	3470	1	163	5237	LL	2	1	1	0	591027	6563368
6142	talv	1	3472	2	432	5237	LL	2	1	1	0	591026	6563211
6466	talv	1	3913	1	432	4804	LL	2	0	1	0	588005	6562788
6914	talv	1	4520	1	432	3902	LL	2	0	0	0	582026	6543508
7002	talv	1	4608	1	163	3915	LL	2	0	1	0	582008	6550288
7004	talv	1	4610	1	432	3915	LL	2	0	1	0	582006	6550441
7016	talv	1	4622	1	163	3917	LL	2	0	1	0	581998	6551373
7024	talv	1	4630	1	163	3918	LL	2	0	1	0	581987	6551991
7186	talv	1	4792	1	163	3944	LL	2	0	1	0	582008	6564727
7255	talv	1	4861	2	163	3505	TV/HP	2	1	1	0	578932	6561055
7335	talv	1	4941	2	163	3492	TV/HP	2	1	1	0	578991	6554544
7426	talv	1	5032	2	163	3477	LL	2	1	1	0	579013	6547052
7445	talv	1	5051	2	432	3474	TV/HP	2	1	1	0	579021	6545567
7688	talv	1	5366	2	163	3046	LL	2	0	0	0	575981	6547607
7690	talv	1	5368	1	432	3046	LL	2	0	0	0	575987	6547766
7710	talv	1	5388	1	163	3049	LL	2	0	1	0	576013	6549378
7776	talv	1	5454	1	163	3060	LL	2	0	1	0	575977	6554739
7788	talv	1	5466	1	163	3062	LL	2	0	1	0	575990	6555730
7794	talv	1	5472	2	432	3063	LL	2	0	1	0	576006	6556231
7803	talv	1	5481	1	163	3064	TV/HP	2	0	1	0	576018	6556888
8067	talv	1	5826	1	432	2624	TV/HP	2	1	1	0	572969	6552846
8272	talv	1	6109	2	432	2162	LL	2	0	0	0	570013	6537934
8287	talv	1	6124	1	163	2164	TV/HP	2	0	1	0	570051	6538985
8524	talv	1	6361	1	163	2204	LL	2	0	0	0	570027	6558744
8661	talv	1	6579	2	432	1777	TV/HP	2	0	1	0	566963	6561014
8840	talv	1	6758	1	163	1748	LL	2	1	1	0	567032	6546580
9080	talv	1	7073	1	163	1315	LL	2	0	1	0	563972	6546194
9099	talv	1	7092	1	163	1318	TV/HP	2	0	1	0	563951	6547627
9606	talv	1	7761	1	163	451	LL	2	0	1	0	557989	6546029
9608	talv	1	7763	2	432	451	LL	2	0	1	0	557988	6546186
9668	talv	1	7823	1	163	460	LL	2	0	1	0	557977	6550982
9765	talv	1	8025	2	432	9167	TV/HP	2	0	1	0	554899	6554594
9913	talv	1	8173	1	163	9172	LL	2	0	0	0	554864	6542712

### Avastamisfunktsioon

Mudeli võrrand:  $\sim mc ds(\text{key} = \text{"hn"}, \text{formula} = \sim \text{size})$

Valitud avastamisfunktsioon: half-normal key function

Mudeli koond:

```
Summary for ds object
Number of observations : 41
Distance range       : 0 - 1500
AIC                  : 65.4104
```

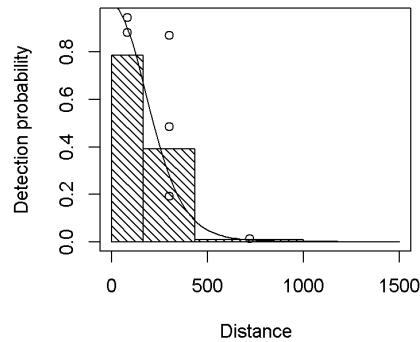
Detection function:  
Half-normal key function

Detection function parameters

Scale Coefficients:  

	estimate	se
(Intercept)	4.6918300	0.4360869
size	0.4112133	0.2777553

	Estimate	SE	CV
Average p	0.1599508	0.02613886	0.1634181
N in covered region	256.3287752	55.84600942	0.2178687



Joonis A.47: Avastamisfunktsioon: talv – kaurid.

### Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{coast05}, k = 4)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-88.10030	0.01568	-5620	<2e-16 ***

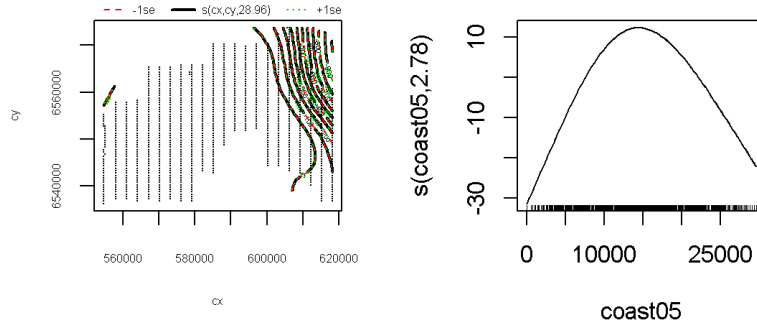
---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	28.958	28.999	4010823	<2e-16 ***
s(coast05)	2.779	2.968	12025643	<2e-16 ***

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.117 Deviance explained = 39.3%  
GCV = 1.5624 Scale est. = 2.6852e-06 n = 1109



Joonis A.48: Tiheduspinna tunnused: talv – kaurid.

## Hõbekajakas *Larus argentatus*

### Andmetabel

Tabel A.25: Andmetabel: talv – hõbekajakas.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y	
3219	talv	256	6017	7	163	9081	TV/HP	1	0	0	2	618163	6541255
3948	talv	256	8591	1	432	8242	LL	2	0	0	0	611948	6553660
4166	talv	256	11091	1	163	7841	LL	2	1	1	0	608974	6569461
4168	talv	256	11111	1	432	7841	LL	2	1	1	0	608977	6569308
4384	talv	256	13271	2	432	7808	LL	2	1	0	0	608980	6552523
4626	talv	256	16251	1	432	7376	LL	2	0	0	0	605983	6552885
4634	talv	256	16331	1	432	7378	LL	2	0	0	0	605977	6553537
4636	talv	256	16351	1	163	7378	LL	2	0	0	0	605977	6553699
4859	talv	256	18581	1	432	7412	TV/HP	2	0	1	0	605967	6570785
4914	talv	256	19411	1	163	6981	LL	2	1	1	0	602973	6571262
4923	talv	256	19501	1	432	6980	TV/HP	2	0	1	0	602998	6570672
4979	talv	256	20061	1	432	6971	TV/HP	2	0	1	0	602977	6566414
5004	talv	256	20311	1	432	6967	LL	2	1	1	0	603006	6564369
5178	talv	256	22051	1	432	6939	LL	2	1	0	0	602986	6550339
5331	talv	256	24331	1	163	6507	TV/HP	2	0	1	0	599979	6550383
5402	talv	256	25041	1	432	6519	LL	2	0	0	0	599983	6556036
5410	talv	256	25121	1	163	6520	LL	2	0	0	0	599984	6556661
5443	talv	256	25451	1	432	6525	TV/HP	2	0	1	0	599983	6559155
5446	talv	256	25481	1	432	6525	LL	2	0	1	0	599993	6559473
5532	talv	256	26341	1	1000	6539	LL	2	0	1	0	600042	6566161
5570	talv	256	26721	1	163	6545	LL	2	0	1	0	600021	6569122
5578	talv	256	26801	8	1000	6546	LL	2	0	1	0	600027	6569739
5596	talv	256	27761	1	432	6113	LL	2	1	1	0	597011	6569156
5896	talv	256	31511	1	1000	5659	LL	2	0	1	0	594094	6558106
5953	talv	256	32081	1	432	5667	TV/HP	2	0	1	0	594030	6562352
5984	talv	256	3239	1	432	5672	LL	2	0	1	0	594010	6564800
5995	talv	256	3250	1	432	5674	TV/HP	2	0	1	0	594006	6565564
5996	talv	256	3251	1	432	5674	LL	2	0	1	0	594006	6565717
6000	talv	256	3255	2	1000	5675	LL	2	0	1	0	594011	6566022
6020	talv	256	3275	2	1000	5678	LL	2	0	1	0	594006	6567552
6030	talv	256	3285	8	432	5679	LL	2	0	1	0	594010	6568317
6104	talv	256	3434	1	432	5243	LL	2	1	1	0	591023	6566166
6106	talv	256	3436	1	432	5243	LL	2	1	1	0	591023	6566012
6110	talv	256	3440	1	163	5242	LL	2	1	1	0	591022	6565705
6114	talv	256	3444	1	163	5241	LL	2	1	1	0	591024	6565393
6152	talv	256	3482	1	432	5235	LL	2	1	1	0	591022	6562430
6322	talv	256	3769	1	432	4781	LL	2	0	1	0	588078	6551461
6411	talv	256	3858	1	432	4795	TV/HP	2	0	0	0	588002	6558334
6438	talv	256	3885	1	1000	4800	LL	2	0	1	0	588042	6560558
6450	talv	256	3897	1	163	4802	LL	2	0	1	0	588029	6561513
6458	talv	256	3905	1	432	4803	LL	2	0	1	0	588023	6562155
6462	talv	256	3909	2	432	4803	LL	2	0	1	0	588012	6562469
6468	talv	256	3915	2	432	4804	LL	2	0	1	0	588004	6562947
6469	talv	256	3916	1	432	4804	TV/HP	2	0	1	0	588004	6562947
6470	talv	256	3917	1	163	4805	LL	2	0	1	0	588001	6563109
6495	talv	256	3942	6	432	4809	TV/HP	2	0	1	0	587982	6565031
6500	talv	256	3947	30	432	4810	LL	2	0	1	0	587976	6565514
6502	talv	256	3949	40	1000	4810	LL	2	0	1	0	587974	6565678
6504	talv	256	3951	20	432	4810	LL	2	0	1	0	587971	6565838
6506	talv	256	3953	160	432	4811	LL	2	0	1	0	587966	6566000
6508	talv	256	3955	20	163	4811	LL	2	0	1	0	587966	6566163
6510	talv	256	3957	20	163	4811	LL	2	0	1	0	587956	6566328
6512	talv	256	3959	20	432	4811	LL	2	0	1	0	587954	6566491
6514	talv	256	3961	300	163	4812	LL	2	0	1	0	587952	6566656
6549	talv	256	3996	3	432	4817	TV/HP	2	0	1	0	588003	6569419
6720	talv	256	4245	20	432	4362	LL	2	1	1	0	584998	6557564
6948	talv	256	4554	1	432	3907	LL	2	0	0	0	582020	6546097
7110	talv	256	4716	1	163	3932	LL	2	0	1	0	582025	6558729
7136	talv	256	4742	1	432	3936	LL	2	0	1	0	581999	6560793
7171	talv	256	4777	1	1000	3941	TV/HP	2	0	1	0	581983	6563466
7215	talv	256	4821	5	1000	3511	TV/HP	2	1	1	0	578919	6564301
7221	talv	256	4827	3	432	3438	TV/HP	2	1	1	0	578871	6563825

7229	talv	256	4835	1	163	3509	TV/HP	2	1	1	0	578936	6563173
7246	talv	256	4852	12	432	3506	LL	2	1	1	0	578925	6561704
7263	talv	256	4869	2	432	3503	TV/HP	2	1	1	0	578936	6560392
7469	talv	256	5075	2	432	3470	TV/HP	2	1	0	0	578991	6543592
7696	talv	256	5374	1	1000	3047	LL	2	0	0	0	576008	6548250
7707	talv	256	5385	1	432	3049	TV/HP	2	0	1	0	576014	6549056
7814	talv	256	5492	1	1000	3066	LL	2	0	1	0	576017	6557858
7843	talv	256	5521	1	432	3071	TV/HP	2	0	1	0	576037	6560153
7860	talv	256	5538	2	1000	3074	LL	2	0	1	0	576015	6561622
7880	talv	256	5558	50	432	3077	LL	2	0	1	0	576007	6563260
7900	talv	256	5578	1	1000	3080	LL	2	0	1	0	575998	6564891
8326	talv	256	6163	1	432	2171	LL	2	0	0	0	569986	6542183
8586	talv	256	6423	20	1000	2214	LL	2	0	0	0	569962	6563953
8587	talv	256	6424	1	1000	2214	TV/HP	2	0	1	0	569962	6563953
8591	talv	256	6428	1	163	2215	TV/HP	2	0	1	0	569973	6564287
8597	talv	256	6434	1	432	2216	TV/HP	2	0	1	0	569992	6564784
8622	talv	256	6540	3	163	1783	LL	2	1	1	0	566972	6564096
8623	talv	256	6541	1	163	1783	TV/HP	2	0	1	0	566972	6564096
9058	talv	256	7051	2	163	1311	LL	2	0	1	0	564008	6544455
9149	talv	256	7142	25	163	1326	TV/HP	2	0	1	0	563980	6551629
9760	talv	256	8020	40	163	9167	LL	2	0	1	0	554894	6554913

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{mcfs}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{sun})$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object

Number of observations : 83  
Distance range : 0 - 1500  
AIC : 167.146

Detection function:

Hazard-rate key function

Detection function parameters

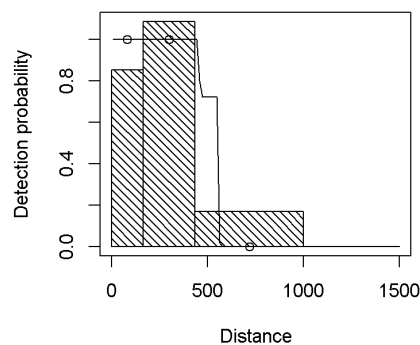
Scale Coefficients:

	estimate	se
(Intercept)	6.3181517	1.0943489
sun1	-0.1968155	0.3730142

Shape parameters:

	estimate	se
(Intercept)	5.519807	421.1063

	Estimate	SE	CV
Average p	0.3520925	0.01857222	0.05274812
N in covered region	235.7334845	24.29155994	0.10304671



Joonis A.49: Avastamisfunktsioon: talv – hõbekajakas *Larus argentatus*.

## Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{depth05}, k = 4) + s(\text{coast05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{depth05}, k = 4) + s(\text{coast05}, k = 4)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-23.83651	0.01428	-1670	<2e-16 ***

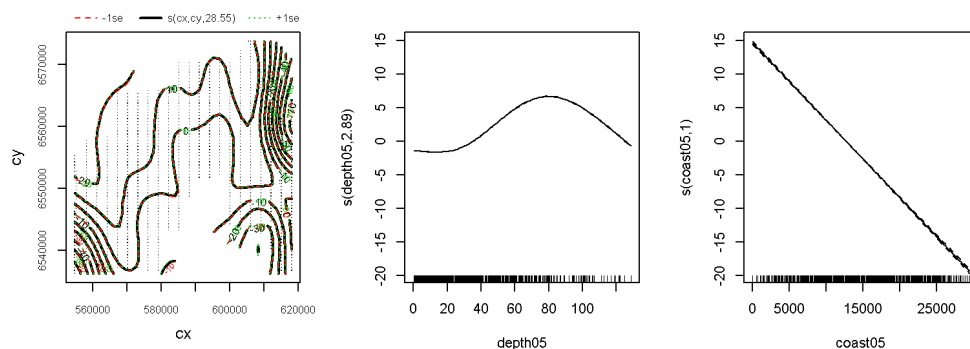
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	28.55	28.96	85461	<2e-16 ***
s(depth05)	2.89	2.99	382435	<2e-16 ***
s(coast05)	1.00	1.00	14048	<2e-16 ***

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.44 Deviance explained = 67%  
 GCV = 7.4284 Scale est. = 0.0013026 n = 1106



Joonis A.50: Tiheduspinna tunnused: talv – hõbekajakas *Larus argentatus*.

## Kalakajakas *Larus canus*

### Andmetabel

Tabel A.26: Andmetabel: talv – kalakajakas.

season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y	
3247	talv	255	8810	2	163	9085	TV/HP	1	0	0	2	618108	6543464
3310	talv	255	15110	380	432	9095	LL	1	0	0	2	618092	6548471
3398	talv	255	23910	180	432	9109	LL	1	0	0	2	618002	6555382
3524	talv	255	39710	2	163	8680	LL	2	0	0	0	614994	6556760
3563	talv	255	43610	2	432	8674	TV/HP	2	0	1	0	614984	6553730
3578	talv	255	4511	1	432	8671	LL	2	0	0	1	614932	6552442
3579	talv	255	45210	2	1000	8671	TV/HP	2	0	1	1	614932	6552442
3595	talv	255	46810	3	432	8597	TV/HP	2	0	1	1	614898	6551159
3603	talv	255	47610	3	1000	8668	TV/HP	2	0	1	1	614906	6550527
3659	talv	255	53210	4	1000	8659	TV/HP	2	0	1	1	614994	6546068
3711	talv	255	58410	20	432	8650	TV/HP	2	0	1	1	614971	6541845
3841	talv	255	75210	30	432	8225	TV/HP	2	0	0	0	612034	6545157
3845	talv	255	7568	50	432	8225	TV/HP	2	0	0	0	612034	6545465
4068	talv	255	9791	1	432	8261	LL	2	0	0	0	612011	6563216
4241	talv	255	11841	1	432	7830	TV/HP	2	1	1	0	608964	6563751
4361	talv	255	13041	1	432	7811	TV/HP	2	1	0	0	608968	6554392
4393	talv	255	13361	1	163	7806	TV/HP	2	1	0	0	608990	6551895





7611	talv	255	5289	2	432	3033	TV/HP	2	0	1	0	576010	6541387
7672	talv	255	5350	1	163	3043	LL	2	0	0	0	575958	6546323
7773	talv	255	5451	1	432	3059	TV/HP	2	0	1	0	575986	6554415
7780	talv	255	5458	1	163	3061	LL	2	0	1	0	575974	6555067
7870	talv	255	5548	40	163	3075	LL	2	0	1	0	576009	6562440
7872	talv	255	5550	20	163	3076	LL	2	0	1	0	576008	6562604
7874	talv	255	5552	250	432	3076	LL	2	0	1	0	576006	6562768
7876	talv	255	5554	40	1000	3076	LL	2	0	1	0	576007	6562931
7878	talv	255	5556	20	163	3077	LL	2	0	1	0	576006	6563096
7879	talv	255	5557	150	432	3077	TV/HP	2	0	1	0	576006	6563096
7883	talv	255	5561	100	1000	3077	TV/HP	2	0	1	0	576010	6563425
7902	talv	255	5580	1	432	3081	LL	2	0	1	0	576000	6565055
7920	talv	255	5679	1	163	2648	LL	2	1	1	0	573014	6564669
7924	talv	255	5683	1	432	2647	LL	2	1	1	0	573014	6564348
7926	talv	255	5685	1	432	2647	LL	2	1	1	0	573013	6564188
7927	talv	255	5686	2	432	2647	TV/HP	2	1	1	0	573013	6564188
7928	talv	255	5687	2	432	2647	LL	2	1	1	0	573013	6564030
7932	talv	255	5691	6	432	2646	LL	2	1	1	0	573014	6563710
7951	talv	255	5710	1	432	2643	TV/HP	2	1	1	0	572982	6562270
7985	talv	255	5744	1	163	2638	TV/HP	2	1	1	0	572954	6559518
8330	talv	255	6167	2	432	2172	LL	2	0	0	0	569989	6542514
8584	talv	255	6421	320	1000	2214	LL	2	0	0	0	569957	6563786
8609	talv	255	6527	1	432	1785	TV/HP	2	0	1	0	566920	6565251
8621	talv	255	6539	1	163	1783	TV/HP	2	0	1	0	566975	6564262
8628	talv	255	6546	1	1000	1782	LL	2	1	1	0	566973	6563602
8640	talv	255	6558	4	432	1780	LL	2	1	1	0	566995	6562624
8651	talv	255	6569	1	163	1778	TV/HP	2	0	1	0	566984	6561817
8753	talv	255	6671	1	432	1762	TV/HP	2	0	1	0	566945	6563664
9147	talv	255	7140	15	163	1325	TV/HP	2	0	1	0	563982	6551466
9233	talv	255	7310	1	163	906	TV/HP	2	1	1	0	560947	6567962
9537	talv	255	7692	1	432	440	TV/HP	2	0	1	0	558023	6540595
9626	talv	255	7781	1	163	454	LL	2	0	1	0	557993	6547614
9711	talv	255	7866	2	1000	467	TV/HP	2	0	1	0	557945	6554297
9758	talv	255	8018	400	163	9185	LL	2	0	1	0	554881	6555078
9759	talv	255	8019	5	432	9185	TV/HP	2	0	1	0	554881	6555078
9761	talv	255	8021	1	163	9167	TV/HP	2	0	1	0	554894	6554913
9762	talv	255	8022	3	163	9167	LL	2	0	1	0	554898	6554755
9763	talv	255	8023	7	1000	9167	TV/HP	2	0	1	0	554898	6554755
9764	talv	255	8024	20	432	9167	LL	2	0	1	0	554899	6554594
9766	talv	255	8026	20	432	9155	LL	2	0	1	0	554894	6554438
9768	talv	255	8028	20	432	9155	LL	2	0	1	0	554890	6554279
9770	talv	255	8030	20	432	9155	LL	2	0	1	0	554887	6554121
9772	talv	255	8032	1	163	9210	LL	2	0	1	0	554889	6553962
9773	talv	255	8033	3	163	9210	TV/HP	2	0	1	0	554889	6553962
9777	talv	255	8037	1	432	9210	TV/HP	2	0	1	0	554893	6553641
9778	talv	255	8038	10	432	9199	LL	2	0	1	0	554894	6553483
9780	talv	255	8040	22	432	9199	LL	2	0	1	0	554892	6553325
9782	talv	255	8042	40	432	9199	LL	2	0	1	0	554892	6553167
9784	talv	255	8044	20	163	9199	LL	2	0	1	0	554894	6553010
9786	talv	255	8046	20	163	9180	LL	2	0	1	0	554897	6552853
9788	talv	255	8048	40	163	32	LL	2	0	1	0	554902	6552694
9790	talv	255	8050	40	432	32	LL	2	0	1	0	554907	6552533
9792	talv	255	8052	20	163	31	LL	2	0	1	0	554909	6552376
9794	talv	255	8054	41	163	31	LL	2	0	1	0	554913	6552219
9796	talv	255	8056	100	432	31	LL	2	0	1	0	554917	6552063
9798	talv	255	8058	40	432	30	LL	2	0	1	0	554922	6551904
9800	talv	255	8060	20	163	30	LL	2	0	1	0	554929	6551746
9802	talv	255	8062	28	432	30	LL	2	0	1	0	554936	6551589
9803	talv	255	8063	27	163	30	TV/HP	2	0	1	0	554936	6551589
9804	talv	255	8064	54	163	29	LL	2	0	1	0	554942	6551431
9805	talv	255	8065	30	432	29	TV/HP	2	0	1	0	554942	6551431
9806	talv	255	8066	31	163	29	LL	2	0	1	0	554949	6551272
9809	talv	255	8069	20	163	29	LL	2	0	1	0	554955	6551114
9811	talv	255	8071	66	432	28	LL	2	0	1	0	554960	6550954
9812	talv	255	8072	20	163	28	TV/HP	2	0	1	0	554960	6550954

## Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{mcfs}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{size})$

Valitud avastamisfunktsioon: hazard-rate key function

Mudeli koond:

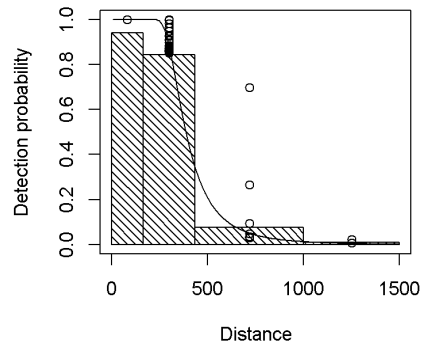
```
Summary for ds object
Number of observations : 189
Distance range         : 0 - 1500
AIC                    : 372.1452

Detection function:
Hazard-rate key function

Detection function parameters
Scale Coefficients:
      estimate      se
(Intercept) 5.834648914 0.1155290501
size        0.002435461 0.0008651971

Shape parameters:
      estimate      se
(Intercept) 1.539289 0.2042698
```

	Estimate	SE	CV
Average p	0.2853851	0.02325567	0.08148872
N in covered region	662.2629182	67.74185280	0.10228846



Joonis A.51: Avastamisfunktsioon: talv – kalakajakas *Larus canus*.

### Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy) + s(ship05, k = 4)$

Mudeli koond:

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy) + s(ship05, k = 4)$

Parametric coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-17.853	1.158	-15.42	<2e-16 ***

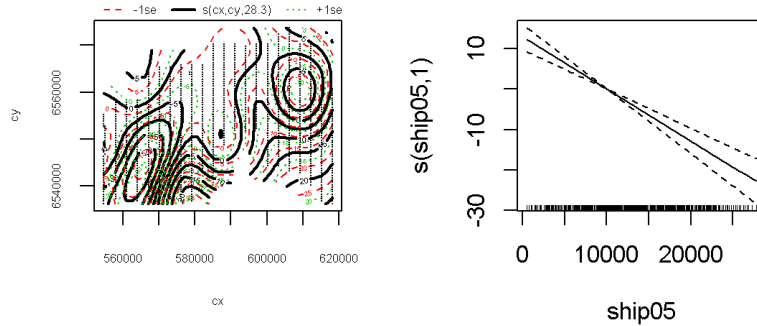
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	28.3	28.88	12.12	< 2e-16 ***
s(ship05)	1.0	1.00	67.01	7.08e-16 ***

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.128 Deviance explained = 46.7%  
GCV = 70.404 Scale est. = 84.925 n = 1109



Joonis A.52: Tiheduspinna tunnused: talv – kalakajakas *Larus canus*.

## Aul *Clangula hyemalis*

### Andmetabel

Tabel A.27: Andmetabel: talv – aul.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
3185	talv	93	26100	20	432	9076	TV/HP	1	0	0	2	618160	6538564
3207	talv	93	48100	60	1000	9079	TV/HP	1	0	0	2	618173	6540300
3471	talv	93	34410	1	163	8689	TV/HP	2	0	1	2	614966	6561013
3820	talv	93	73110	200	432	8222	LL	2	0	0	0	612002	6543590
3822	talv	93	73310	400	432	8222	LL	2	0	0	0	612004	6543740
3824	talv	93	73510	200	163	8222	LL	2	0	0	0	612011	6543941
3835	talv	93	74610	50	432	8224	TV/HP	2	0	0	0	612030	6544701
3849	talv	93	7601	120	432	8226	TV/HP	2	0	0	0	612035	6545774
3855	talv	93	76610	50	1000	8227	TV/HP	2	0	0	0	612022	6546239
3881	talv	93	7921	10	432	8231	TV/HP	2	0	0	2	611975	6548286
4109	talv	93	10201	6	163	8267	TV/HP	2	0	1	0	611951	6506412
4404	talv	93	13471	120	432	7804	LL	2	1	0	0	608977	6550955
4427	talv	93	13701	9	432	7801	TV/HP	2	1	0	0	608991	6549217
4462	talv	93	14051	2	432	7795	LL	2	1	0	0	608999	6546388
4481	talv	93	14241	2	163	7792	TV/HP	2	1	0	0	608967	6544984
4482	talv	93	14251	320	432	7792	LL	2	1	0	0	608965	6544828
4484	talv	93	14271	110	1000	7792	LL	2	1	0	0	608966	6544670
4490	talv	93	14331	120	1000	7791	LL	2	1	0	0	608966	6544199
4520	talv	93	15191	4	163	7359	LL	2	0	0	0	605999	6544130
4530	talv	93	15291	2	432	7360	LL	2	0	0	0	605980	6544953
4563	talv	93	15621	3	432	7366	TV/HP	2	0	1	0	606020	6547524
4568	talv	93	15671	2	163	7367	LL	2	0	0	0	605996	6548020
4630	talv	93	16291	1	432	7377	LL	2	0	0	0	605979	6553210
4763	talv	93	17621	2	163	7397	TV/HP	2	0	1	0	606057	6563441
4857	talv	93	18561	3	432	7412	TV/HP	2	0	1	0	605966	6570634
4922	talv	93	19491	2400	1000	6980	LL	2	1	1	0	602998	6570672
4945	talv	93	19721	2	163	6977	TV/HP	2	0	1	0	603016	6569040
4949	talv	93	19761	2	163	6976	TV/HP	2	0	1	0	603006	6568742
4951	talv	93	19781	6	432	6976	TV/HP	2	0	1	0	603002	6568590
4962	talv	93	19891	240	432	6974	LL	2	1	1	0	602975	6567668
4970	talv	93	19971	4	163	6973	LL	2	1	1	0	602968	6567043
4985	talv	93	20121	6	432	6970	TV/HP	2	0	1	0	602988	6565948
4992	talv	93	20191	280	432	6969	LL	2	1	1	0	602996	6565323
5002	talv	93	20291	120	163	6968	LL	2	1	1	0	603005	6564530
5015	talv	93	20421	2	432	6966	TV/HP	2	0	1	0	603011	6563564
5028	talv	93	20551	1200	432	6963	LL	2	1	0	0	603010	6562447
5029	talv	93	20561	50	163	6963	TV/HP	2	1	0	0	603010	6562447
5032	talv	93	20591	350	1000	6963	LL	2	1	0	0	602990	6562124
5036	talv	93	20631	8	163	6962	LL	2	1	0	0	602974	6561798
5130	talv	93	21571	1400	432	6947	LL	2	1	1	0	602993	6554217
5198	talv	93	22251	180	1000	6936	LL	2	1	0	0	603013	6548731
5265	talv	93	23671	15	432	6497	TV/HP	2	0	0	1	599950	6545226
5313	talv	93	24151	20	432	6504	TV/HP	2	0	1	0	599976	6548994
5357	talv	93	24591	2	432	6511	TV/HP	2	0	1	0	599978	6552439
5373	talv	93	24751	120	432	6514	TV/HP	2	0	1	0	599970	6553688
5409	talv	93	25111	1	432	6520	TV/HP	2	0	1	0	599983	6556507
5425	talv	93	25271	1	432	6522	TV/HP	2	0	1	0	599968	6557745
5439	talv	93	25411	30	432	6524	TV/HP	2	0	1	0	599972	6558841
5496	talv	93	25981	40	163	6533	LL	2	0	1	0	600024	6563340
5498	talv	93	26001	20	163	6533	LL	2	0	1	0	600024	6563496
5500	talv	93	26021	120	432	6534	LL	2	0	1	0	600023	6563651
5502	talv	93	26041	100	432	6534	LL	2	0	1	0	600020	6563808
5553	talv	93	26551	2	163	6542	TV/HP	2	0	1	0	600017	6567714
5569	talv	93	26711	10	432	6544	TV/HP	2	0	1	0	600020	6568967
5575	talv	93	26771	130	163	6545	TV/HP	2	0	1	0	600023	6569428
5583	talv	93	26851	3	1000	6547	TV/HP	2	0	1	0	600022	6570045
5679	talv	93	28591	14	163	6100	TV/HP	2	0	0	0	596979	6562793
5734	talv	93	29141	2	163	6091	LL	2	1	0	0	596974	6558396
5736	talv	93	29161	4	432	6091	LL	2	1	0	0	596976	6558235
5805	talv	93	29851	60	1000	6080	TV/HP	2	0	0	0	597023	6552866
5832	talv	93	30871	4	163	5649	LL	2	0	0	0	594078	6553186
5843	talv	93	30981	12	432	5650	TV/HP	2	0	1	0	594106	6553970



8872	talv	93	6790	11	432	1742	LL	2	1	1	0	567003	6543994
8874	talv	93	6792	8	163	1742	LL	2	1	1	0	566999	6543834
8880	talv	93	6798	4	432	1741	LL	2	1	1	0	566989	6543351
8937	talv	93	6855	55	432	1732	TV/HP	2	0	1	0	566991	6538808
8988	talv	93	6981	2	163	1301	LL	2	0	1	0	564032	6539086
8990	talv	93	6983	4	432	1301	LL	2	0	1	0	564044	6539235
8991	talv	93	6984	20	432	1301	TV/HP	2	0	1	0	564044	6539235
8995	talv	93	6988	2	432	1302	TV/HP	2	0	1	0	564051	6539536
8998	talv	93	6991	4	163	1302	LL	2	0	1	0	564045	6539835
9000	talv	93	6993	2	432	1302	LL	2	0	1	0	564040	6539985
9051	talv	93	7044	4	163	1310	TV/HP	2	0	1	0	564021	6543830
9056	talv	93	7049	100	432	1311	LL	2	0	1	0	564012	6544300
9063	talv	93	7056	2	163	1312	TV/HP	2	0	1	0	564000	6544772
9121	talv	93	7114	4	432	1321	TV/HP	2	0	1	0	563971	6549392
9127	talv	93	7120	35	163	1322	TV/HP	2	0	1	0	563983	6549870
9129	talv	93	7122	3	163	1323	TV/HP	2	0	1	0	563985	6550029
9281	talv	93	7358	2	163	899	TV/HP	2	1	1	0	560990	6554120
9334	talv	93	7411	150	1000	890	LL	2	0	1	0	561019	6549755
9460	talv	93	7537	30	1000	869	LL	2	0	0	0	560989	6539364
9808	talv	93	8068	3	163	29	TV/HP	2	0	1	0	554949	6551272
9813	talv	93	8073	80	163	28	LL	2	0	1	0	554963	6550794
9895	talv	93	8155	2	163	9146	LL	2	0	0	0	554876	6544176
9979	talv	93	8239	120	1000	9196	LL	2	0	0	0	554847	6537312

## Avastamisfunktsioon

Mudeli võrrand:  $\sim \text{mc}(\text{key} = \text{"hr"}, \text{formula} = \sim \text{sun})$

Valitud avastamisfunktsioon: hazard-rate key function

Mudeli koond:

Summary for ds object

Number of observations : 192  
Distance range : 0 - 1500  
AIC : 413.4677

Detection function:

Hazard-rate key function

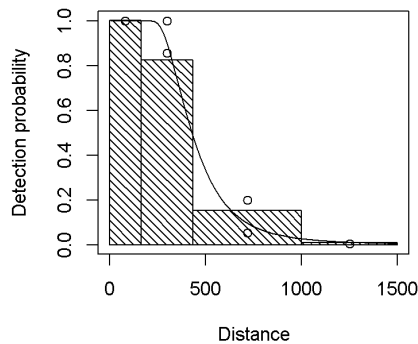
Detection function parameters

Scale Coefficients:  
estimate se  
(Intercept) 5.8615581 0.1358868  
sun1 0.3407316 0.1399263

Shape parameters:

estimate se  
(Intercept) 1.395314 0.1911369

	Estimate	SE	CV
Average p	0.31888	0.02448735	0.07679175
N in covered region	602.10736	58.64987527	0.09740767



Joonis A.53: Avastamisfunktsioon: talv – aul *Clangula hyemalis*.

## Tiheduspind

Mudeli võrrand:  $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$   
 Mudeli koond:

Family: quasipoisson  
 Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Parametric coefficients:  

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-16.14	1.07	-15.08	<2e-16 ***

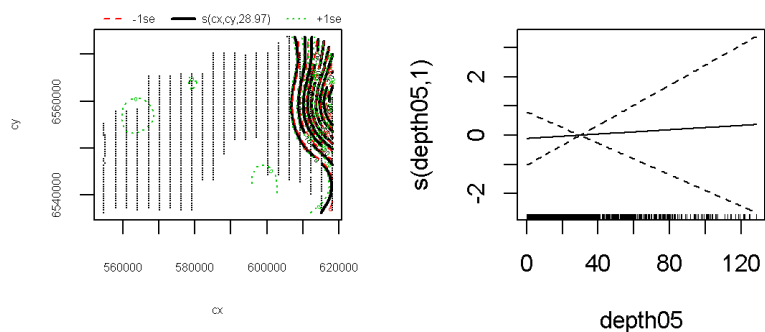
---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:  

	edf	Ref.df	F	p-value
s(cx,cy)	28.97	29	4.629	1.59e-14 ***
s(depth05)	1.00	1	0.059	0.809

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.0577 Deviance explained = 33.4%  
 GCV = 194.94 Scale est. = 444.36 n = 1106



Joonis A.54: Tiheduspinna tunnused: talv – aul *Clangula hyemalis*.

## Sõtkas *Bucephala clangula*

### Andmetabel

Tabel A.28: Andmetabel: talv – sõtkas.

	season	species	object	size	distance	Sample.Label	obs	vis	sun	wav	ice	x	y
3243	talv	90	8410	10	163	9085	TV/HP	1	0	0	2	618109	6543151
3771	talv	90	6445	2	163	9587	TV/HP	2	0	1	1	614939	6536992
3780	talv	90	6911	24	163	8216	LL	2	0	0	1	612024	6540612
3784	talv	90	6951	32	432	8216	LL	2	0	0	1	612017	6540922
3802	talv	90	71310	8	432	8219	LL	2	0	0	0	611984	6542259
3810	talv	90	72110	8	432	8220	LL	2	0	0	0	611985	6542847
3814	talv	90	7251	6	163	8221	LL	2	0	0	0	611987	6543143
3816	talv	90	7271	2	432	8221	LL	2	0	0	0	611993	6543291
3818	talv	90	7291	20	432	8221	LL	2	0	0	0	611999	6543439
3826	talv	90	73710	20	432	8223	LL	2	0	0	0	612017	6544093
3830	talv	90	74110	20	163	8223	LL	2	0	0	0	612025	6544396
3832	talv	90	74310	2	163	8224	LL	2	0	0	0	612028	6544549
3833	talv	90	74410	200	432	8224	TV/HP	2	0	1	0	612028	6544549
3834	talv	90	74510	4	163	8224	LL	2	0	0	0	612030	6544701
3836	talv	90	74710	8	163	8224	LL	2	0	0	0	612031	6544853
3839	talv	90	75010	70	163	8225	TV/HP	2	0	1	0	612033	6545006

3842	talv	90	75310	20	432	8225	LL	2	0	0	0	612034	6545311
3843	talv	90	75410	80	432	8225	TV/HP	2	0	1	0	612034	6545311
3844	talv	90	75510	4	432	8225	LL	2	0	0	0	612034	6545465
3846	talv	90	7571	2	432	8226	LL	2	0	0	0	612035	6545620
3871	talv	90	78210	6	432	8229	TV/HP	2	0	1	2	611980	6547499
3894	talv	90	80510	1	163	8233	LL	2	0	0	0	611977	6549387
5826	talv	90	30811	6	163	5648	LL	2	0	0	0	594082	6552703
6285	talv	90	3615	2	163	5214	TV/HP	2	0	1	0	590998	6551995
6318	talv	90	3765	2	163	4781	LL	2	0	1	0	588057	6551162
6873	talv	90	4398	4	432	4338	TV/HP	2	1	0	0	584954	6545582
6876	talv	90	4401	10	163	4337	LL	2	1	0	0	584942	6545267
6905	talv	90	4430	2	432	4333	TV/HP	2	1	0	0	584989	6543068
6926	talv	90	4532	2	163	3903	LL	2	0	0	0	582024	6544408
7349	talv	90	4955	3	163	3489	TV/HP	2	1	1	0	578988	6553401
7495	talv	90	5101	1	163	3465	TV/HP	2	1	0	0	578933	6541450
7581	talv	90	5259	5	432	3029	TV/HP	2	0	1	0	576040	6539104
7662	talv	90	5340	1	163	3042	LL	2	0	0	0	575955	6545524
8002	talv	90	5761	8	163	2635	LL	2	1	1	0	572933	6558057
9212	talv	90	7205	1	432	1336	LL	2	0	1	0	563981	6556841
9387	talv	90	7464	3	163	881	TV/HP	2	1	1	0	560936	6545477
9901	talv	90	8161	2	163	9202	LL	2	0	0	0	554870	6543690

## Avastamisfunktsioon

**Mudeli võrrand:**  $\sim \text{cds}(\text{key} = \text{"hr"}, \text{formula} = \sim 1)$

**Valitud avastamisfunktsioon:** hazard-rate key function

**Mudeli koond:**

Summary for ds object  
 Number of observations : 37  
 Distance range : 0 - 1500  
 AIC : 54.54388

Detection function:  
 Hazard-rate key function

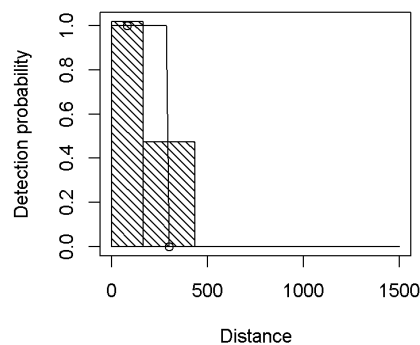
Detection function parameters  
 Scale Coefficients:  

estimate	se
(Intercept) 5.685627	0.12486

Shape parameters:  

estimate	se
(Intercept) 11.29716	230.0597

	Estimate	SE	CV
Average p	0.1964036	0.0245225	0.1248577
N in covered region	188.3876115	36.3877241	0.1931535



Joonis A.55: Avastamisfunktsioon: talv – sõtkas *Bucephala clangula*.



## Tiheduspind

**Mudeli võrrand:**  $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$   
**Mudeli koond:**

Family: quasipoisson  
Link function: log

Formula:  
 $D \sim s(cx, cy) + s(\text{depth05}, k = 4)$

Parametric coefficients:  
Estimate Std. Error t value Pr(>|t|)  
(Intercept) -77.3810 0.3534 -218.9 <2e-16 \*\*\*  
---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

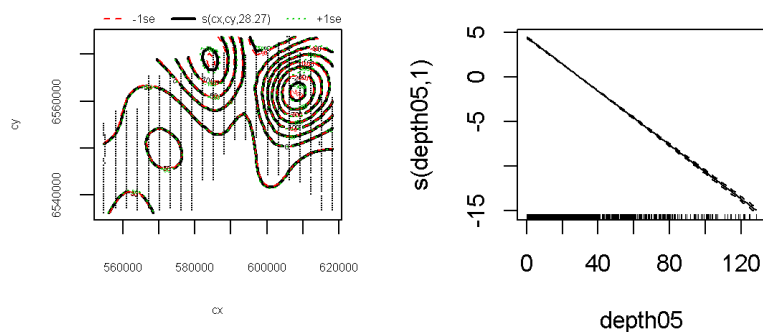
Approximate significance of smooth terms:

	edf	Ref.df	F	p-value
s(cx,cy)	28.27	28.74	9782	<2e-16 ***
s(depth05)	1.00	1.00	10421	<2e-16 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) = 0.696 Deviance explained = 81.1%  
GCV = 5.4557 Scale est. = 0.019894 n = 1106



Joonis A.56: Tiheduspinna tunnused: talv – sõtkas *Bucephala clangula*.