

Outline of the Danish
fisheries research/fishing industry survey for cod
in the Kattegat 4nd quarter

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Introduction

Since 2003 the cod fishery in Kattegat has been restricted by steadily decreasing quotas due to low abundance of cod estimated from the cod assessment. ICES consider, however, the cod assessment in Kattegat uncertain due to the catch data quality and the analytic assessment has not been accepted by ACFM in recent years. The assessment has shown a discrepancy between the estimated fishing mortality and the reported landings and ICES assumed that the majority of the unallocated mortality was caused by discard, but other factors such as migration, non reported landings and re-allocation of catches also could be part of the problem. Furthermore, the surveys conducted at present in the Kattegat area are not very suited for estimation of cod abundance mainly due to the low coverage and sampling intensity. The abundance estimate in the areas is hence rather uncertain and only shows trends in stock development, and the assessment of the cod stock would, without doubt, benefit significantly from a survey directly aimed at cod. The 5 August 2006 a tender was submitted by Swedish Board of Fisheries, Institute of Marine Research (IMR-SE) in response to the open call for tenders, Reference No FISH/2006/15 Studies and Pilot projects for carrying out the common fisheries policy, Lot No 3: "Evaluation of the pilot effort regime in Kattegat" from Directorate-General for Fisheries and Maritime Affairs.

Both Swedish and Danish scientists and the fishermen's organisations agree that the poor survey quality hampers the assessment of the cod stock in Kattegat and an expert group consisting of people from the fisherman's organisations and scientists has designed an improved survey. The initiative has been taken by the LOT 3 project group and was originally a strictly Swedish project. However, the involvement of Denmark has been considered as an improvement of the project and the survey has been designed in all details in agreement between fishers and scientists from both countries. The survey has been conducted since 2008 with a gap in 2012 and only Swedish vessels participating in 2013. The survey strata has been moderated slightly since 2013 to take into account the closed area very a separate strata has been placed.

The goal

The goal of the Kattegat cod survey is to estimate the abundance, biomass and distribution of cod and to establish a fisheries independent time series of catch and effort series. Furthermore, a recruitment index will be established. The results should be used, together with commercial catch and effort data to strengthen the scientific advice on the cod stock in Kattegat. The survey will also monitor the amount and distribution of cod within the proposed "closed area" in order to analyse the effect of the closure.

Restrictions

The 24 commercial Swedish trawlers participating in the survey conduct the survey without any restrictions in the vessels quota, days at sea regulation and with dispensation from all by-catch regulations. From Denmark the Danish scientific vessel Havfisken is participating.

Survey design

Survey area

The survey area is restricted to the Kattegat area covering from Skagen, to the Tistlarna lighthouse and in south by an south-eastwards line between Ellekilde Hage and Lerbjerg and south-westwards by a line between Gniben og Hassensør on Djursland. Further, the area is restricted by the 20 m depth contour line and the area is split in areas "North" and "South" (Fig. 1).

However, in two fjords Laholmsbugten and Skældervigen fishing at stations shallower than 20 meter will take place and 1 or two stations will be placed in a small area in The Sound "Kilen".

Survey method and stratification

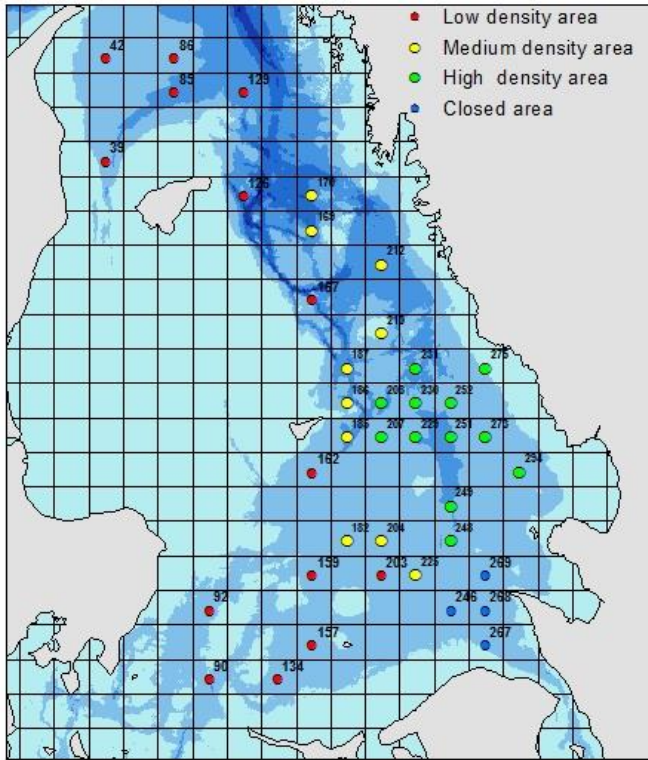
The survey is designed as a random stratified bottom trawl survey. The survey area is since 2013 stratified in four strata: a stratum with high cod density, a stratum with medium density and a stratum with low cod density based on information from the fishers a fourth strata has been designate to make sure not stations are placed within the closed area. Each stratum is further subdivided in 5*5 nm squares. Most stations according to the area are allocated to the high density stratum. In the forthcoming years stations will be allocated to the different strata in order to minimize the variance of the estimation of the cod biomass. The survey design allows a post-stratification of the survey area if necessary without losing comparability with previous surveys and hence to take changes in the main focus area into account if the stock distribution is changing between years or the stock is increasing or decreasing.

Station (tow) location

The survey is planned with in average 3.3 trawl hauls per day in 6 days for each of the 4 vessels i.e in total 80 trawl hauls. The hauls are allocated randomly to the 5*5 nm squares and each vessel is allocated 20 different squares. In the high and medium density strata several vessels are allowed to fish in the same square. In the low density stratum only one haul is allowed in each square. Furthermore the low density area is divided in a Southern and Northern area.

Numbers of stations by vessel, stratum and area

Ship	High density	Medium density	Low density (South)	Low density (North)	Closed area	Total
Den ₁	12	10	7 4	1	4	40



Stationer	y	x
39	57.36890	10.73973
42	57.61832	10.75163
85	57.53052	11.05677
86	57.61365	11.06147
126	57.27578	11.34978
129	57.52511	11.36580
167	57.02037	11.63879
90	56.11470	11.12955
92	56.28098	11.13878
134	56.10921	11.42712
157	56.18931	11.58144
159	56.35554	11.59266
162	56.60486	11.60973
203	56.34891	11.89200
169	57.18657	11.65063
170	57.26966	11.65660
182	56.43541	11.74833
185	56.68470	11.76648
186	56.76780	11.77259
187	56.85089	11.77873
204	56.43200	11.89831
210	56.93050	11.93688
212	57.09665	11.95002
225	56.34533	12.04162
207	56.68126	11.91744
208	56.76434	11.92389
229	56.67763	12.06837
230	56.76070	12.07515
231	56.84377	12.08196
248	56.42463	12.19816
249	56.50769	12.20516
251	56.67381	12.21926
252	56.75687	12.22637
273	56.66982	12.37012
275	56.83591	12.38504
294	56.58261	12.51320
246	56.25849	12.18428
267	56.17150	12.32630
268	56.25456	12.33350
269	56.33762	12.34075

Stations valid for Havfisken 4Q 2017

Target species

The survey is directed to demersale species in Kattegat, but designed for cod. The catch of all species is, however, recorded and the survey results are also made available for the assessment of sole, plaice and Norwegian lobster.

Survey period

The survey will take place during October and November in - 2017. There is planned with 12-40 stations fishing days. The survey period can, however, be extended in case of bad weather or

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~~technical problems.~~ Trawling is restricted to 15 min. before sunrise to 15 min. after sun set. For the first time the survey will be conducted in combination with the KASU survey as the survey area is similar. We will however need to evaluate if this synergy is possible between the 2 different surveys or if we next year need to separate them again.

KASU II/Torsketoget	39056-17	19/10-2/11	1. halvdel	15	Søren Grøndby
					Per Christensen
					Peter Vingaard Larsen
					Brian Thomsen
KASU II/Torsketoget		2/11-17/11	2. halvdel	15	Aage Thaarup
					Jens Holm
					Mads Jensen
					Jan Pedersen

Vessels and Fishing gear

Vessels

The survey is conducted by four commercial chartered trawlers, two covering the northern and two the southern area, respectively. Two vessels are Swedish and the other two are Danish. The vessels have been appointed due to the similarity in engine power, length and applicability for scientific investigations.

DK-Vessel 1

Danish participant	Havfisken
Engine (KW):	
Tonnage (BRT):	48
Length (m):	17,5
Door type/size	
Owner	DTU Aqua

The trawl is a commercial bottom trawl provided by the LOT 3 project.

Trawl (see annex): A Swedish TV-trawl 112 ft 24-464

13 pieces of 8'' balls and 16 pieces of 6'' balls.

4 thumps rubber discs at 10 cm

Mesh size in cod end: 70 mm stretch mesh.

Otter boards: 64''-66'' "Thyborøn"

Warp: 35 mm .

Mellem liner der benyttes må i 2017 varierer i længden mellem 54 og 154 meter. "Grimdelen" på 27 meter skal bi- beholdes hvilket gives en total længde på mellem 81 og 181 meter. Det er bare vigtigt at notere hvor lang en line der er benyttet.

The trawls are checked continuously during the survey.

Fishing operation

Within each square the skipper decides on the best way to fish at the location (e.g. exact position, tow direction). Such an approach has been used successfully in the north-eastern North Sea and the Skagerrak in comparable projects (Wieland et al. 2008).

Maximum 5 min of the total trawling time should be outside the allocated square. If the 5 minutes are exceeded the haul should be terminated. Trawl procedure:

Towing time: 60/30 min (towing time down to 20~~5~~ min is accepted).

Towing speed: Between 2.7 kn. and 3.4 over the seabed, but speed should not vary within a station. Hauls start: when the trawl is considered going stable on the bottom, roughly 5-7 min after wires are connected.

Haul end: when hauling back starts.

Trawled distance: is estimated from the plotter.

Around 50% of the hauls can be conducted with a 30 min towing time. It will be up to the skipper to decide which of the hauls that should be reduced to 30 min, they should however be spread over the entire survey area. It is important that there is a clear registration of the tows towing time for later analysis.

Sampling of catch

There will be two technicians/scientists from DTU-Aqua, who will be responsible for processing the catch, on board.

The catch will be processed in accordance with BITS standard operating procedures for trawl surveys. After each haul the catch is sorted by species and weighed to nearest 0.1 kg and the number of specimens recorded. All fish species are measured as total length (TL) to 1.0 cm below. Norwegian lobster is measured in mm.

Cod otoliths (1 per cm group per station) are sampled for age determination. The same fish that are sampled for age are sampled for genetics. (DNA til Jakob)

Additional scientific samples can be collected if requested (genetic, tagging, frozen samples, etc.).

Screening of data

All trawl data (position, wingspread, towing speed etc.) and catch and length frequency data on sole, cod, plaice and Norwegian lobster are screened for unrealistic figures before further estimations.

Extra information to be sampled

In 2017, 25 adult flatfish of ~~each of the species of turbot, sole and brill~~ should be sampled, for genetic samples at a later stage. The fish is to be frozen whole with station information attached on

the plastic bag. The samples are for Jacob Hemmer. (Der kommer en opdateret plan fra Jakob inden togt start)

Data

Data are stored in a standard data base and can, be uploaded to the ICES DATRAS system.

Estimation of stock indices

CPUE

CPUE is estimated as mean catch (kg or number) per hour (cod also number by age per hour).

Biomass and abundance

Hence no stations are deeper than 100 m, biomass and abundance is estimated for depths between 20 and 100 m. The survey area is stratified in density strata and the area between 20 and 100 m has been estimated. The total survey area is 19037.6 km² (Table 1).

Biomass and abundance estimates is based on the randomly selected stations and obtained by applying the swept area method:

Swept area= (estimated trawling speed *1.852)* wing spread * trawling time/60

using the recorded towing speed, wing spread and trawling time and taking the catchability coefficient as 1.0 and the stratum area as weighting factor (Cohran, 1977).

All catches are standardized to 1 km² swept prior to further calculations.

Reporting

The survey results are reported to WGBAFAS as a working document. The document includes information about aerial distribution, CPUE, biomass, abundance and length frequencies on cod, sole, plaice and Norwegian lobster together with age distribution of cod.

References

Cochran, W.G. 1977. Sampling Techniques. Third edition. Wiley & Sons.

ICES. 2005. Report of the Workshop on Survey Design and Data Analysis (WKSAD). ICES CM 2005/ B:07, 174 pp.

Wieland, K. and Storr-Paulsen, M. 2006. Effect of tow duration on catch and size composition of Northern shrimp (*Pandalus borealis*) and Greenland halibut (*Reinhardtius hippoglossoides*) in the West Greenland Bottom trawl survey. Fisheries Research 78: 276-285.

Wieland, K., E.M. Fenger Pedersen, H.J. Olesen & J.E. Beyer (2008): Survey results from a Danish collaborative biologist-fishermen project on spatially-explicit management methods (REX) for North Sea cod. Working document, ICES WGNSSK, 7.-13. May 2008.

Fig. 1. Distribution of hauls by type and squares.

Table 1. Area (km²) 20-120 m depth by depth area.

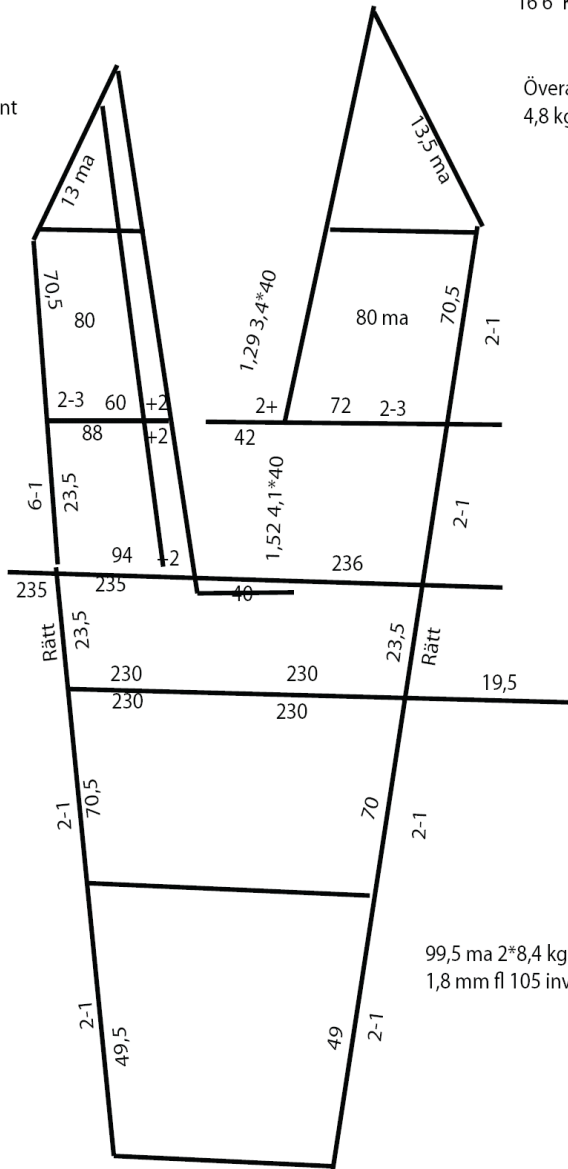
High density	Medium density	Low density	Closed area	All
21 squares	26 squares	65 squares	8 squares	120 squares
1800.8 km ²	2229.5 km ²	5573.8 km ²	686 km ²	10290 km ²

TV112 - 24 -646

Underarmar
4,6 kg 1,8 ma fl
80 mm utan kant
med kil

13 8" Kulor
16 6" Kulor

Överarm
4,8 kg utan kant



99,5 ma 2*8,4 kg
1,8 mm fl 105 inv

Tabel 11. To eksempler på hvordan afstanden mellem skovlene kan beregnes ud fra spilet i wirene.

1. metode

1) En pind, skruenøgle, kniv eller hvad man nu har for hånden sættes ind, hvor afstanden mellem wirene lige svarer til længden af genstanden. Fra dette punkt finder man ud af, hvor mange gange dette mål kan ligge langs wiren op til det sted, hvor wirene går sammen.

2) Afstanden mellem skovlene fås ved at dele wirlængden med »antallet af mål«.
Eksempel: Fra det sted på wirene, hvor spredningen er 1 skruenøgle, er der 5,5 skruenøgle op til hvor wirene går sammen.

Wirlængde: $150 \text{ fv} = 274 \text{ m}$.
Afstand mellem skovle: $274:5,5 = 50 \text{ m}$.

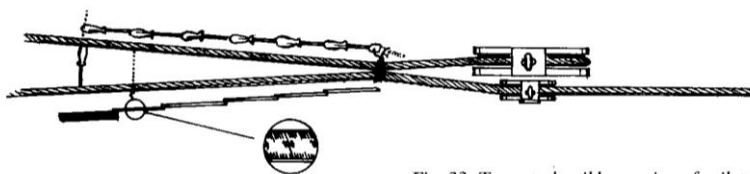


Fig. 33: To metoder til beregning af spilet er her illustreret. Det letter udmålingen, hvis wirene kan samles med et båndsel.

2. metode

1) Mål afstanden mellem wirene 1 meter fra, hvor de går sammen.

2) Afstanden hér ganget med wirlængden giver afstanden mellem skovlene.

Eksempel: Spredningen på 1 meter: $18 \text{ cm} = 0,18 \text{ m}$
Wirlængde: $150 \text{ fv} = 274 \text{ m}$
Afstand mellem skovle: $0,18 \times 274 = 49 \text{ m}$

Stationer				SE Cindy	SE Tärnan	Havfiskan	
1	39	57.36890	10.73973				1
2	40	57.45204	10.74367				
3	41	57.53518	10.74764				
4	42	57.61832	10.75163			1	1
5	43	57.70146	10.75565				
6	44	57.78460	10.75967				
7	45	57.86774	10.76369			1	
8	46	57.95088	10.76771				
9	47	57.03402	11.06677				1
10	48	57.11716	11.07079				
11	49	57.20030	11.07481				1
12	50	57.28344	11.07883			1	
13	51	57.36658	11.08285				
14	52	57.44972	11.08687				1
15	53	57.53286	11.09089				
16	54	57.61600	11.09491				
17	55	57.69914	11.09893				1
18	56	57.78228	11.10295				
19	57	57.86542	11.10697				
20	58	57.94856	11.11099				1
21	59	58.03170	11.11501			1	
22	60	58.11484	11.11903				
23	61	58.19798	11.12305				1
24	62	58.28112	11.12707				
25	63	58.36426	11.13109				
26	64	58.44740	11.13511				1
27	65	58.53054	11.13913				
28	66	58.61368	11.14315				
29	67	58.69682	11.14717				1
30	68	58.78000	11.15119				
31	69	58.86314	11.15521				
32	70	58.94628	11.15923				1
33	71	59.02942	11.16325				
34	72	59.11256	11.16727				
35	73	59.19570	11.17129				1
36	74	59.27884	11.17531				
37	75	59.36198	11.17933				
38	76	59.44512	11.18335				1
39	77	59.52826	11.18737				
40	78	59.61140	11.19139				
41	79	59.69454	11.19541				1
42	80	59.77768	11.19943				
43	81	59.86082	11.20345				
44	82	59.94396	11.20747				1
45	83	60.02710	11.21149				
46	84	60.11024	11.21551				
47	85	60.19338	11.21953				1
48	86	60.27652	11.22355				
49	87	60.35966	11.22757				
50	88	60.44280	11.23159				1
51	89	60.52594	11.23561				
52	90	60.60908	11.23963				
53	91	60.69222	11.24365				1
54	92	60.77536	11.24767				
55	93	60.85850	11.25169				
56	94	60.94164	11.25571				1
57	95	61.02478	11.25973				
58	96	61.10792	11.26375				
59	97	61.19106	11.26777				1
60	98	61.27420	11.27179				
61	99	61.35734	11.27581				
62	100	61.44048	11.27983				1
63	101	61.52362	11.28385				
64	102	61.60676	11.28787				
65	103	61.68990	11.29189				1
66	104	61.77304	11.29591				
67	105	61.85618	11.29993				
68	106	61.93932	11.30395				1
69	107	62.02246	11.30797				
70	108	62.10560	11.31199				
71	109	62.18874	11.31601				1
72	110	62.27188	11.32003				
73	111	62.35502	11.32405				
74	112	62.43816	11.32807				1
75	113	62.52130	11.33209				
76	114	62.60444	11.33611				
77	115	62.68758	11.34013				1
78	116	62.77072	11.34415				
79	117	62.85386	11.34817				
80	118	62.93700	11.35219				1
81	119	63.02014	11.35621				
82	120	63.10328	11.36023				
83	121	63.18642	11.36425				1
84	122	63.26956	11.36827				
85	123	63.35270	11.37229				
86	124	63.43584	11.37631				1
87	125	63.51898	11.38033				
88	126	63.60212	11.38435				
89	127	63.68526	11.38837				1
90	128	63.76840	11.39239				
91	129	63.85154	11.39641				
92	130	63.93468	11.40043				1
93	131	64.01782	11.40445				
94	132	64.10096	11.40847				
95	133	64.18410	11.41249				1
96	134	64.26724	11.41651				
97	135	64.35038	11.42053				
98	136	64.43352	11.42455				1
99	137	64.51666	11.42857				
100	138	64.59980	11.43259				
101	139	64.68294	11.43661				1
102	140	64.76608	11.44063				
103	141	64.84922	11.44465				
104	142	64.93236	11.44867				1
105	143	65.01550	11.45269				
106	144	65.09864	11.45671				
107	145	65.18178	11.46073				1
108	146	65.26492	11.46475				
109	147	65.34806	11.46877				
110	148	65.43120	11.47279				1
111	149	65.51434	11.47681				
112	150	65.59748	11.48083				
113	151	65.68062	11.48485				1
114	152	65.76376	11.48887				
115	153	65.84690	11.49289				
116	154	65.93004	11.49691				1
117	155	66.01318	11.50093				
118	156	66.09632	11.50495				
119	157	66.17946	11.50897				1
120	158	66.26260	11.51299				
121	159	66.34574	11.51701				
122	160	66.42888	11.52103				1
123	161	66.51202	11.52505				
124	162	66.59516	11.52907				
125	163	66.67830	11.53309				1
126	164	66.76144	11.53711				
127	165	66.84458	11.54113				
128	166	66.92772	11.54515				1
129	167	67.01086	11.54917				
130	168	67.09400	11.55319				
131	169	67.17714	11.55721				1
132	170	67.26028	11.56123				
133	171	67.34342	11.56525				
134	172	67.42656	11.56927				1
135	173	67.50970	11.57329				
136	174	67.59284	11.57731				
137	175	67.67598	11.58133				1
138	176	67.75912	11.58535				
139	177	67.84226	11.58937				
140	178	67.92540	11.59339				1
141	179	68.00854	11.59741				
142	180	68.09168	11.60143				
143	181	68.17482	11.60545				1
144	182	68.25796	11.60947				
145	183	68.34110	11.61349				
146	184	68.42424	11.61751				1
147	185	68.50738	11.62153				
148	186	68.59052	11.62555				
149	187	68.67366	11.62957				1
150	188	68.75680	11.63359				
151	189	68.83994	11.63761				
152	190	68.92308	11.64163				1
153	191	69.00622	11.64565				
154	192	69.08936	11.64967				
155	193	69.17250	11.65369				1
156	194	69.25564	11.65771				
157	195	69.33878	11.66173				
158	196	69.42192	11.66575				1
159	197	69.50506	11.66977				
160	198	69.58820	11.67379				
161	199	69.67134	11.67781				1
162	200	69.75448	11.68183				
163	201	69.83762	11.68585				
164	202	69.92076	11.68987				1
165	203	70.00390	11.69389				
166	204	70.08704	11.69791				
167	205	70.17018	11.70193				1
168	206	70.25332	11.70595				
169	207	70.33646	11.70997				
170	208	70.41960	11.71399				1
171	209	70.50274	11.71801				
172	210	70.58588	11.72203				
173	211	70.66902	11.72605				1
174	212	70.75216	11.73007				
175	213	70.83530	11.73409				
176	214	70.91844	11.73811				1
177	215	71.00158	11.74213				
178	216	71.08472	11.74615				
179	217	71.16786	11.75017				1
180	218	71.25100	11.75419				
181	219	71.33414	11.75821				
182	220	71.41728	11.76223				1
183	221	71.50042	11.76625				
184	222	71.58356	11.77027				
185	223	71.66670	11.77429				1
186	224	71.74984	11.77831				
187	225	71.83298	11.78233				
188	226	71.91612	11.78635				1
189	227	72.00000	11.79037				
190	228	72.08388	11.79439				
191	229	72.16776	11.79841				1
192	230	72.25164	11.80243				
193	231	72.33552	11.80645				
194	232	72.41940	11.81047				1
195	233	72.50328	11.81449				
196	234	72					