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SHORT COMMUNICATION

Juvenile Atlantic herring (*Clupea harengus*) use a time-compensated sun compass for orientation

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ABSTRACT

Atlantic herring (*Clupea harengus*), an ecologically and economically important species in the northern hemisphere, shows pronounced seasonal migratory behaviour. To follow distinctive migration patterns over hundreds of kilometers between feeding, overwintering and spawning grounds, they are probably guided by orientation mechanisms. We tested whether juvenile spring-spawning Atlantic herring, caught in the western Baltic, use a sun compass for orientation just before they start leaving their hatching area. Fish were randomly divided into two groups, one of them clock-shifted 6 h backwards, to investigate whether they shift their orientation direction accordingly. Individual fish were placed in a circular bowl and their orientation was tested multiple times with the sun as a sole visual orientational cue. Our results show for the first time that juvenile Atlantic herring use a time-compensated sun compass during their migration. Their swimming direction was impaired, but still present, even when the sky was very cloudy, indicating additional orientation capabilities.

KEY WORDS: Atlantic herring, Migration, Sun compass orientation, Orientation behaviour

INTRODUCTION

The Atlantic herring (*Clupea harengus* Linnaeus 1758), an ecologically and economically important species in the northern hemisphere, exhibits complex seasonal migration behaviour. In the western Baltic Sea, adult herring migrate hundreds of kilometers between the Sound (overwintering grounds), coastal areas of the western Baltic Sea (spawning grounds) and Kattegat, Skagerrak and eastern North Sea (summer feeding grounds) (see Fig. 1; Aro, 1989, Clausen et al., 2015, Miethe et al., 2014). Goal-oriented migration over mid-range distances is a difficult task and requires the right cues for orientation and navigation. Fish can use a range of sensory cues for orientation: sound (e.g. Radford et al., 2011), olfaction (e.g. Gerlach et al., 2007), Earth's magnetic field (e.g. Bottesch et al., 2016, Cresci et al., 2017) or celestial cues, such as the sun (e.g. Loyacano et al., 1977, Mouritsen et al., 2013, Quinn, 1980). While orientation based on olfactory and auditory cues is usually limited to a few kilometers (e.g. leaving a fjord), magnetic and sun compass orientation is mostly used for long-distance migration (e.g. herring migration between spawning and feeding grounds). To be able to effectively use the sun as a compass, animals must observe the path of the sun and link the sun's azimuth at different time points during the day to their circadian clock (reviewed in Mouritsen, 2018).

Western Baltic spring-spawning herring (WBSSH) migrate from their overwintering grounds to their coastal spawning grounds to lay benthic eggs in shallow, low-saline areas such as Greifswald Bay and Kiel Canal mainly between February and May (Fig. 1; Biester, 1989, Clausen et al., 2015, Paulsen et al., 2014, Polte et al., 2017). After spawning, adult herring leave the area. Yolk-sac larvae are found close to the spawning beds. Pre-flexion and flexion stage larvae are then observed in pelagic areas and post-flexion larvae return to shallow littoral areas where they remain until after their metamorphosis to the juvenile stage (Polte et al., 2017). It is assumed that juveniles initially stay near the coast and only start migrating to offshore nursery areas between Germany and Denmark in July/August (Oeberst et al., 2009; Payne et al., 2009; Polte et al., 2017). However, the exact path during the first migration of juvenile herring (age 0) is unknown.

To date, only Atlantic herring larvae have been tested in various orientation experiments between 14 and 28 days post-hatch (Cresci et al., 2020), weeks before they begin their first long-distance migration. Results of this study propose the potential use of a sun compass, but could not exclude the use of other orientational cues. To date, there are no published data on orientation mechanisms in juvenile herring as they embark on their first long-distance migration. In this study, we caught juvenile WBSSH in summer (July and August) 2021 in the Kiel Fjord and investigated whether they use a sun compass to orient towards offshore nursery areas and the Sound, where Baltic herring overwinter (Fig. 1; Payne et al., 2009).

MATERIALS AND METHODS

Experimental animals

All animal procedures were approved by the Animal Care and Use Committees of the Niedersächsisches Landesamt für Verbraucherschutz und Lebensmittelsicherheit (LAVES, Oldenburg, Germany), Az.: 33.19-42502-04-17/2721 and performed in accordance with the relevant guidelines and regulations. Permission for scientific fishing using fishing rods, fish traps and sink nets was granted by the Schleswig–Holstein State office for agriculture, environment and rural areas to GEOMAR.

The experiments were performed at the University of Oldenburg, Germany, from August to October 2021. Juvenile herring were caught in the Kiel Fjord (54°19′46.0″N, 10°08′58.1″E) in July and August 2021 from the pier in front of the GEOMAR Helmholtz

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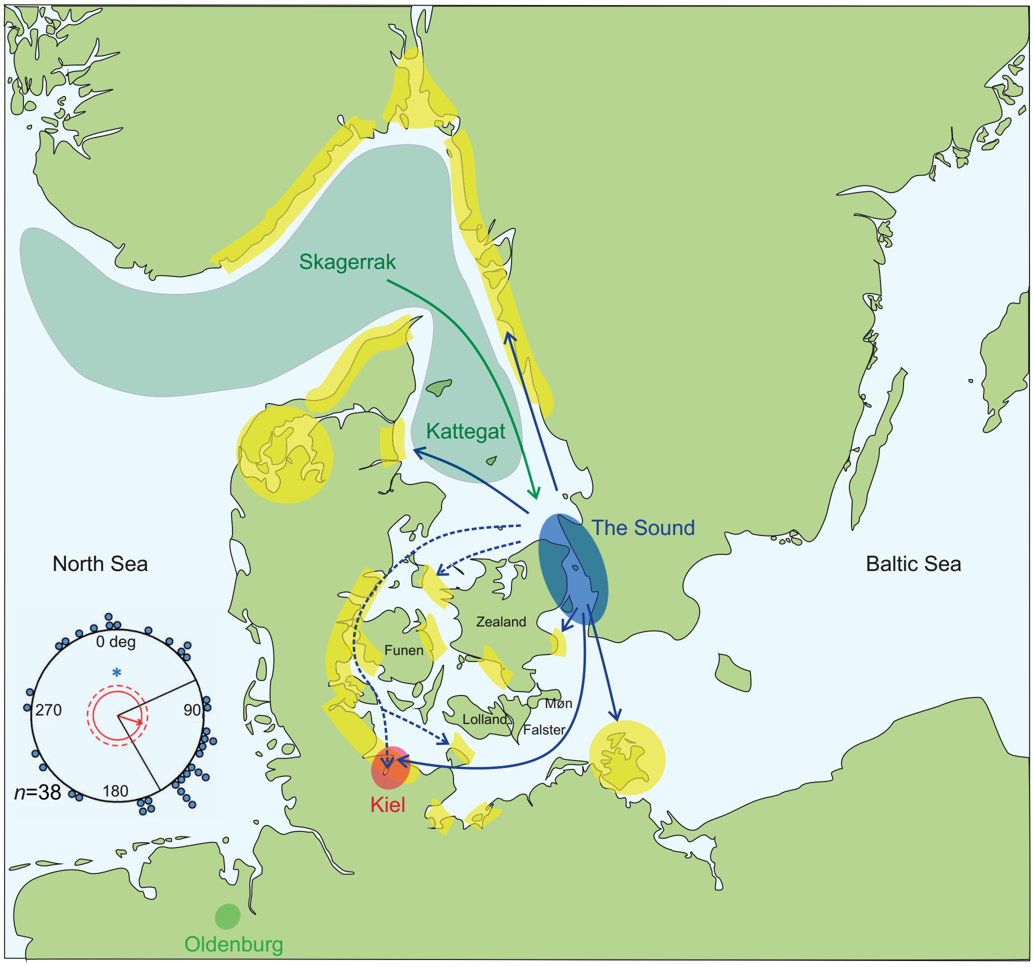

Fig. 1. Map showing the suggested seasonal migrations of adult western Baltic spring-spawning herring (WBSSH) and the orientation of juveniles. The summer feeding areas are located in Kattegat, Skagerrak and the eastern North Sea (dark green). Overwintering takes place in the Sound (blue); from there, herring migrate to different coastal areas for spawning (yellow); dashed lines show routes that are less known to be used. Juveniles for our experiment were caught in the Kiel Fjord (red) and tested in Oldenburg (green). Map modified from Aro (1989), Clausen et al. (2015), Nielsen et al. (2001). Circular diagram (left corner) shows the sun compass orientation of juvenile herring tested under normal conditions; each dot represents the mean direction of one fish tested 2–6 times; red arrow indicates the group's mean vector (ESE).

Centre for Ocean Research Kiel west shore building using large hand nets. Fish were kept in a flow-through tank (with Baltic Sea water) for 2 weeks and fed 2–3 times a day with *Artemia* sp. shrimp or natural plankton (caught in the Kiel Fjord) before being transported to Oldenburg (180 km SE) in plastic cooling boxes filled with continuously aerated Baltic Sea water (according to Kiel Fjord conditions: 15 PSU and 17°C).

After arriving in Oldenburg, fish were separated into two groups (sun compass and time-shift sun compass) and transferred into 200 l glass aquaria with water conditions matching those in Kiel Fjord. The tanks were filled with natural seawater, temperature was controlled by a TECO Aquarium Cooler TK 500 and for continuous filtration, an external filter was used (Eheim Professional). The light cycle was set to 14 h light:10 h dark with lights on between 06:00 h and 20:00 h for normal sun compass experiments and between 00:00 h and 14:00 h for time-shift sun compass experiments. The time-shifted tank was covered with opaque curtains to prevent external light from influencing the light:dark cycle. Once per day, when the light was on for both groups, the juveniles were fed *Artemia* sp. shrimp, enriched with Aqua Biotica Orange+ (Mrutzek Meeres-Aquaristik). The time-shift sun compass group was clock-shifted for 7 days before starting the experiments.

Subsequent to performing the orientation test, the body length of all fish in each experimental group was measured. In the normal sun compass group, the juveniles measured 5.8±1.7 cm (mean±s.d.) and in the time-shift sun compass group they were 5.2±0.8 cm. Animals tested in September (second cohort) had a standard length of 8.0±0.8 cm.

Sun compass orientation tests

In total, 79 fish were tested, with 38 juvenile herring in the normal sun compass experiment and 41 juveniles in the time-shift sun compass experiment. A clock-shift is necessary to exclude the use of additional omnipresent cues like the earth's magnetic field. Each individual fish was tested at least twice (2–6 times) in each condition, respectively. This multiple-testing method is also used in migratory birds (Hein et al., 2011; Wiltschko et al., 1993) to gain reasonable accuracy on the intended mean orientation direction. Additionally, multiple testing of the same individuals can significantly reduce the total number of experimental animals needed, which complies with the 3Rs principle. All of the tests were performed between 08:00 h and 13:00 h for time-shifted fish and between 08:00 h and 16:00 h for normal sun compass experimental fish.

During the experiments, juvenile herring were transferred into testing bowls (Ø 30 cm) filled with 5 l of sea water (temperature and salinity similar to housing tank water) and placed on top of a 10 l bucket that was positioned outside in the field with a clear, unhindered view to the sky and no visible landmarks. After 5 min of acclimatization, each herring was tested individually; pictures were taken every 10 s for 20 min using a GoPro camera (GoPro Hero 4 silver) placed on the bottom of the bucket aligned to the north (see Fig. 2A). The position of the fish's head relative to the center of the testing bowls was assessed by uploading the recording in ImageJ (National Institutes of Health, Bethesda, Maryland, USA) and clicking on the fish's head every 30 s (in every 3rd frame). By choosing 30 s intervals, we made sure to have no correlation between the successive data points due to lag of time in between them (autocorrelation). The resulting 40 captured positions per tested fish were then translated into compass directions. In addition to the orientation direction, three different people assessed cloud cover in 5% steps based on the recorded sky during the experiments (cameras were placed under the testing bowls and pointed at the sky). We averaged these judgments of cloud cover.

After each experimental run, the juvenile herring were removed from the experimental setup and placed in the shade to rest for at least 30–45 min before being tested again.

Correction of time-shift sun compass data

It is not known yet if fish are able to exactly measure the sun's azimuth or if they just estimate the azimuth in accordance to their internal clock – assuming a steady shift throughout the day. Therefore, we used two different methods to correct for the sun position at different times of the day and consequently correct the raw data that have been collected during the time-shift sun compass experiments. One is the generalized correction and the other is the accurate correction.

Using the generalized correction, a 15 deg change in sun azimuth per hour is assumed (Lambrinos et al., 1997), leading to a 90 deg shift in 6 h. These 90 deg were added to every mean vector that had been calculated using the 40 positional data points of each significant experimental run to get a generalized corrected mean vector.

For the accurate correction, the exact position of the sun at the specific location, day and time of each experimental run (at a time point mid-experiment, meaning after 10 min of the 20 min trial) was determined using www.sunearthtools.com (October 2020, based on Michalsky, 1988, see Fig. 2B). Afterwards, the position of the sun 6 h after each experimental run was also determined. The deviance of the two angles is calculated by subtracting the sun position during the actual experiment from the sun position of the expected experimental time. This deviance is then added to the original mean vector to get the accurate corrected mean vector.

Data analysis and statistics

All data were analysed using the circular statistics program Oriana (Kovach, 2011) as well as R (version 4.1.3) with ggplot2 (Wickham, 2016). From the 40 observed directions in the respective experimental run of each individual, we calculated the mean vector of orientation. We analyzed whether orientation preference was statistically different from a random distribution using the Rayleigh Uniformity Test [P<0.05 in our case corresponds to a length of mean vector (**r**)>0.272]. The mean direction of a fish during one trial was averaged with the mean direction of the same fish during the following trials to gain only one direction per individual that was used to assess the groups' mean orientation direction.

To evaluate whether the fish were able to effectively use the sun as an orientation cue, the group result of the normal sun compass experiment was initially compared with that from the uncorrected time-shift experiment using a Mardia–Watson–Wheeler test. After proving that both data sets differed significantly, the data of the normal sun compass experiment were compared with those of the corrected time-shift data (generalized and accurate). We hypothesized that if the fish used a time-compensated sun compass, the sun compass direction and corrected time shift direction should be the same.

To analyze whether orientation depends on a clear view to the sky, the effect of relative 'cloud cover' on directionality [length of the mean vector (**r**) of every individual experimental run] was determined using logit transformation of the **r** vectors, Bonferroni correction for multiple comparisons and paired t-tests.

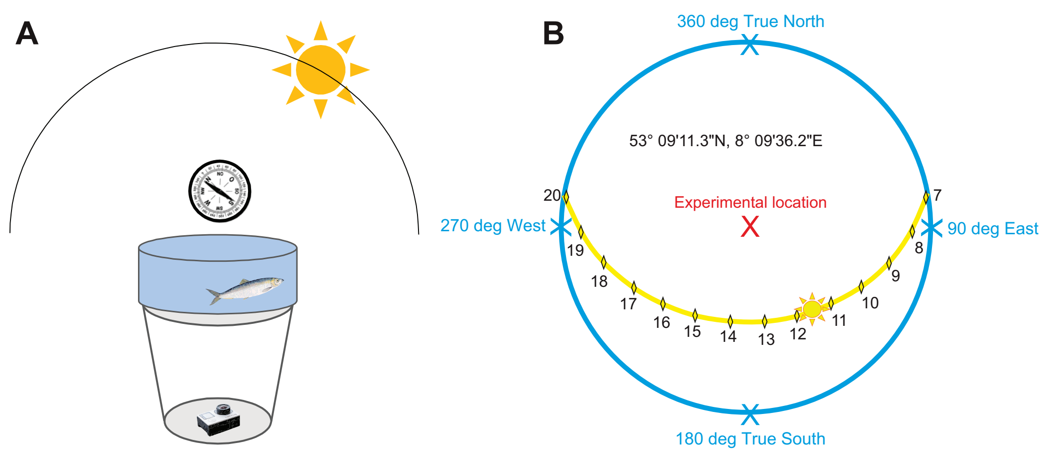

Fig. 2. Experimental setup for testing sun compass orientation and sun azimuth curve. (A) The experimental bowl containing 5 l of sea water as well as one experimental animal was placed on top of a bucket in the field, allowing a clear and unhindered view of the sky. A GoPro camera was placed at the bottom of the bucket, aligned towards north and used for recording time-lapse videos of the experimental runs. Schematic drawing of herring from Gervais et al., 1877. (B) Sun azimuth curve in Oldenburg in August 2021. Note that the sun azimuth moves very consistently at an average of ∼15 deg h^{-1}. In northern Germany, the sun is never positioned directly overhead, which makes it possible to perform sun compass orientation tests at any time between sunrise and sunset. Illustration according to azimuth curve calculated by www.sunearthtools.com.

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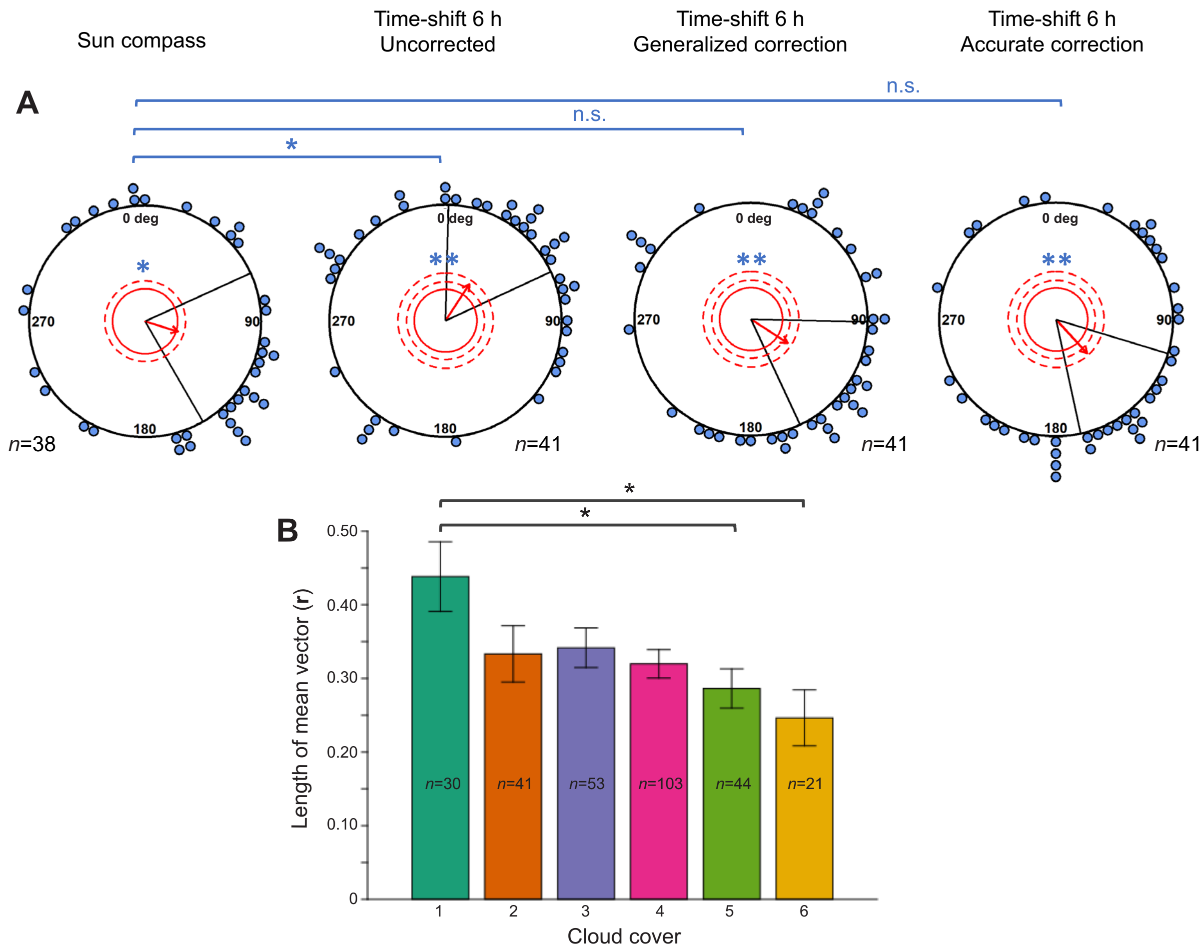

Fig. 3. Juvenile WBSSH are able to use a time-compensated sun compass for orientation. (A) 38 fish kept according to natural light/dark rhythm as well as 41 fish clock-shifted 6 h backwards were tested for their orientation direction under natural skies from August to October 2021. The normal sun compass group had a significant orientation towards ESE (mean direction: 108 deg, P=0.033) while the clock-shifted group oriented significantly towards NNE (mean direction: 33 deg, P=0.003). After correcting the time-shift data (generalized and accurate), the swimming direction of time-shifted juvenile herring points towards ESE (generalized; mean direction: 123 deg, P=0.003) or SE (accurate; mean direction: 137 deg, P=0.002). Every dot indicates the mean direction of one individual fish that oriented significantly at least twice in the given condition. Arrow (vector) indicates the group's mean direction. Red circles indicate the radius of the group mean vector necessary for significance according to the Rayleigh Test (P<0.05, solid circle; P≤0.01, first dashed circle; P≤0.001, second dashed circle). Solid black lines left and right of vector indicate 95% confidence intervals. Graphs created in R (version 4.1.3) using ggplot2 (Wickham, 2016). Group results were compared using a Mardia–Watson–Wheeler test (sun versus TS uncorrected: P=0.014). *P≤0.05, **P≤0.01; n.s., not significant. (B) Bar chart comparing the directedness of fish (indicated by the mean of the **r** vector in every experimental run of sun compass experiments) to the level of cloud. The cloud cover categories 1 to 6 indicate: 0–20% (n=30), >20–40% (n=41), >40–60% (n=53), >60–80% (n=103), >80–100% (n=44) and 100% (n=21) sky coverage, respectively. For statistics, **r** vectors were logit transformed (see Table S2). After Bonferroni correction for multiple comparisons, a paired t-test was performed. Orientation was significantly better at 0–20% cloud cover than at >80–100% or 100% cloud cover. No significant difference was found when cloud cover was between >20 and 100% (categories 2–6). Means±s.e.m.; *P<0.003.

RESULTS AND DISCUSSION

Herring expressed a significant sun compass orientation towards east-southeast (ESE) with a mean vector of 108 deg (see Fig. 3A) (for details, see Table S2). A 6 h clock-shift where the animals are tested before noon, when they think it is afternoon, should lead to a change in orientation when using a sun compass. Indeed, when clock-shifted 6 h backwards, fish showed a significant group orientation towards north-northeast (NNE), with a mean vector of 33 deg (see Fig. 3A) (for details, see Table S3). Comparison of these two datasets by performing a Mardia–Watson–Wheeler test showed a statistical difference (W=8.507, P=0.014). The change in mean vector was 75 deg.

To understand whether herring changed their directional swimming according to the time-shift, we used two different methods (generalized and accurate correction). First, we corrected by adding 90 deg (assuming 15 deg change per hour, see Fig. 2B) and calculated a group swimming direction of time-shifted juvenile herring towards ESE, with a mean vector of 123 deg. By performing correction according to the accurate sun position (see Fig. 3A), herring showed a SE direction with a mean vector of 137 deg. Both these mean swimming orientations were statistically similar to the normal sun compass orientation direction when compared using a Mardia–Watson–Wheeler test (generalized: W=0.309, P=0.857, accurate: W=1.9, P=0.387). The change in mean vector after correction amounts to only 15 deg (generalized correction) and 29 deg (accurate correction), respectively.

To determine if cloud cover influences directional swimming, we tested whether clouds had an impact on the orientation ability of the fish.

We categorized cloud coverage from 1 to 6 [(1) 0–20%, (2) >20–40%, (3) >40–60%, (4) >60–80%, (5) >80–100% and (6) 100% cloudy] and calculated the mean **r** vector±s.e.m.

After logit transforming the **r** vectors and Bonferroni correction for multiple comparisons, the paired *t*-test showed that orientation was significantly higher at 0–20% cloudiness (**r**=0.439±0.04) than at >80–100% (**r**=0.286±0.01) or 100% cloud cover (**r**=0.246±0.05). No significant difference was found when the cloud cover was between >20 and 100% (see Fig. 3B and Table S1). It became apparent that the orientation ability of the fish decreased when the percentage of cloud coverage increased and the most successful tests were conducted when only 0–20% of the sky was covered with clouds.

Taken together, these facts demonstrate that juvenile Atlantic herring are able to use a time-compensated sun compass for orientation. This finding extends the results of Cresci et al. (2020), who used a transparent drifting *in situ* chamber (DISC) in which larvae at 14–16 and 25–28 days post-hatch were tested for their orientation ability in coastal areas of a Norwegian fjord. Cresci et al. (2020) found that both age groups display a significant orientation towards the southeast. However, fish larvae tested in a drifting DISC are exposed to many different environmental cues such as sound, olfactory cues or visual landmarks. Therefore, it is hard to determine the influence of one specific orientation cue. Cresci et al. (2020) suggest that larvae use the sun for orientation, since directionality decreased with increasing cloud cover. We performed experiments on juvenile herring during their first summer/autumn when they start to leave their shallow coastal nursery grounds and head towards offshore nursery or overwintering grounds; therefore, they should be in 'migration mode'. We tested the effect of body length on the individual bearing, but fish of the second cohort (which were older and larger) showed no significantly different bearing than juveniles tested in August. This confirms that the smaller fish from the first cohort were indeed already in 'migration mode' when caught. Furthermore, they were tested under controlled conditions, giving them no visual cues for orientation other than the sun. Clock-shifting the fish, which has not been done in the larval experiments, confirmed that herring juveniles use a time-compensated sun compass for orientation. This conclusion is based on the fact that they misinterpreted the sun's actual position and changed their orientation direction accordingly. In addition, orientation was more precise under sunny conditions than when clouds prevented the direct view of the sun.

Even though Table S1 and Fig. 3B show data collected at '100% cloud cover', which should lead to unoriented fish and therefore non-significant experimental runs, we still observed directional swimming. This could indicate that herring have further orientation capabilities, such as magnetic orientation or perhaps the use of a skylight polarization pattern (Hawryshyn, 1992; Waterman, 2006; Pomozi et al., 2001), but more analysis is needed to determine whether herring can indeed detect these cues. Even if celestial cues such as the sun were used as a primary compass sense in our experiment (as proven by the clock-shift), herring might use additional orientation mechanisms. The sun compass could be used collectively with other compass senses or be part of a cue cascade where one cue comes more into play if a higher ranked one is less available. Magnetic compass orientation would be plausible as this cue is omnipresent and has been demonstrated in a variety of fish species (Bottesch et al., 2016; Cresci et al., 2017; Putman et al., 2020). Whether herring can indeed use additional orientation mechanisms still needs to be determined. Even though herring larvae did not respond to rotations of the magnetic field (Cresci et al., 2020), magnetic orientation might develop in later life stages.

Juvenile Atlantic herring perform their first migration without the guidance of experienced adult herring. Similar difficulties are experienced by juvenile solitary migrating songbirds (e.g. the European blackcap *Sylvia atricapilla*), which use compass orientation during their first migration. When translocated, they do not find their way back to their migration route. However, as experienced adults, they have a map-based orientation and after translocation for several hundred kilometers, can adjust their direction accordingly (Merlin and Liedvogel, 2019). In a different study, we displaced juvenile coral reef fish (*Ostorhinchus doederleini*) by 180 km in a similar manner to the experiments on juvenile birds. We did not observe any change in orientation direction and conclude that they have no positional information and therefore no map-based orientation (L.S., F. Curdt, A. Bally, N. Janzen, P. Kraemer, B. Leberecht, M. J. Kingsford, H. Mouritsen, M. Winklhofer and G.G., unpublished results). Naive travelers, such as juvenile herring, coral reef fish or night-migratory songbirds seem to rely on simple inherited orientation mechanisms, such as a sun compass.

Juvenile Baltic herring start their journey at the end of summer, leaving the coastal areas to find areas of higher food availability (Kvamme et al., 2003). In our study, juveniles oriented to the east-southeast, which might indicate that they take the eastern route to reach the Sound (Fig. 1, solid blue line from the Sound to Kiel) or remain in shallower nursery areas at the German coast, potentially joining schools of similarly sized individuals from different spawning areas (e.g. Lübeck, Wismar, Greifswald) as suggested by Nøttestad et al. (1999). In future experiments, we plan to investigate additional compass- and map-based orientation mechanisms to further characterize the sensory orientation capabilities of Atlantic herring.

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Competing interests
The authors declare no competing or financial interests.

Author contributions
Conceptualization: L.S., M.L., G.G.; Methodology: L.S., M.L., G.G.; Validation: L.S., M.L., W.D.; Formal analysis: L.S., M.L., W.D.; Investigation: L.S., M.L., W.D.; Resources: A.F., C.C.; Data curation: L.S., M.L.; Writing - original draft: L.S., M.L., A.F.; Writing - review & editing: L.S., M.L., A.F., C.C., G.G.; Visualization: L.S., M.L.; Supervision: L.S., M.L., G.G.; Project administration: L.S., M.L., C.C., G.G.; Funding acquisition: G.G.

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Table S1. Length of mean vector (r) and standard error (SE) of experimental runs in different cloudiness categories.

Categories	1	2	3	4	5	6
Cloudiness	0-20%	>20-40%	>40-60%	>60-80%	80-100%	100%
Mean r ± SE	0.439 ± 0.04	0.333 ± 0.03	0.34 ± 0.03	0.320 ± 0.02	0.286 ± 0.01	0.246 ± 0.05

Table S2. Raw data sun compass group

Fish #	Mean Vector(μ)	Length of Mean Vector(r)	r logit transformed	Concen-tration	Circular Variance	Circular Stan-dard Deviation	Rayleigh Test(Z)	Rayleigh Test(p)	Cloudiness
2	45,514°	0,639	0,57	1,677	0,361	54,266°	16,311	2,34E-08	50
2	328,358°	0,409	-0,37	0,895	0,591	76,654°	6,679	1,00E-03	50
2	100,049°	0,647	0,61	1,716	0,353	53,496°	16,729	1,61E-08	60
2	101,024°	0,681	0,76	1,893	0,319	50,249°	18,536	3,89E-09	30
2	123,21°	0,628	0,52	1,627	0,372	55,297°	15,759	3,93E-08	20
2	305,461°	0,041	-3,15	0,083	0,959	144,547°	0,069	9,34E-01	90
3	106,077°	0,645	0,60	1,71	0,355	53,612°	16,665	1,70E-08	40
3	92,559°	0,589	0,36	1,467	0,411	58,912°	13,897	2,83E-07	50
3	295,096°	0,324	-0,74	0,685	0,676	86°	4,204	1,40E-02	70
3	236,669°	0,237	-1,17	0,489	0,763	97,161°	2,255	1,04E-01	20
3	90,185°	0,613	0,46	1,561	0,387	56,722°	15,011	8,38E-08	50
3	139,189°	0,263	-1,03	0,544	0,737	93,706°	2,757	6,30E-02	90
6	119,974°	0,634	0,55	1,657	0,366	54,689°	16,083	2,88E-08	50
6	34,77°	0,243	-1,14	0,502	0,757	96,343°	2,367	9,30E-02	50
6	307,05°	0,564	0,26	1,372	0,436	61,278°	12,744	1,06E-06	40
6	25,645°	0,177	-1,54	0,36	0,823	106,58°	1,257	2,86E-01	50
6	38,818°	0,244	-1,13	0,503	0,756	96,241°	2,381	9,20E-02	70
6	330,96°	0,119	-2,00	0,239	0,881	118,268°	0,564	5,72E-01	70
9	164,078°	0,752	1,11	2,376	0,248	43,299°	22,596	2,19E-10	40
9	166,551°	0,275	-0,97	0,572	0,725	92,048°	3,028	4,70E-02	40
9	83,631°	0,768	1,20	2,525	0,232	41,582°	23,622	1,03E-10	40
9	102,487°	0,46	-0,16	1,034	0,54	71,427°	8,455	1,44E-04	50
9	33,282°	0,168	-1,60	0,34	0,832	108,254°	1,126	3,26E-01	60
9	276,142°	0,195	-1,42	0,397	0,805	103,673°	1,514	2,21E-01	90
11	35,78°	0,668	0,70	1,824	0,332	51,466°	17,85	6,49E-09	70
11	235,292°	0,276	-0,96	0,573	0,724	91,996°	3,037	4,70E-02	70
11	323,239°	0,64	0,58	1,684	0,36	54,124°	16,388	2,18E-08	60
11	71,817°	0,637	0,56	1,67	0,363	54,413°	16,232	2,51E-08	40
11	114,684°	0,581	0,33	1,435	0,419	59,684°	13,515	4,37E-07	70
11	146,07°	0,236	-1,17	0,486	0,764	97,325°	2,233	1,07E-01	100
13	95,136°	0,704	0,87	2,033	0,296	47,977°	19,84	1,54E-09	40
13	145,089°	0,264	-1,03	0,548	0,736	93,5°	2,789	6,10E-02	50
13	337,602°	0,124	-1,96	0,25	0,876	117,051°	0,616	5,43E-01	50
13	167,702°	0,245	-1,13	0,505	0,755	96,124°	2,397	9,00E-02	70
13	294,014°	0,137	-1,84	0,277	0,863	114,237°	0,751	4,75E-01	90
13	72,085°	0,11	-2,09	0,221	0,89	120,429°	0,482	6,20E-01	90
14	59,587°	0,152	-1,72	0,307	0,848	111,246°	0,922	4,00E-01	50
14	50,067°	0,481	-0,08	1,095	0,519	69,306°	9,26	5,87E-05	50
14	104,373°	0,392	-0,44	0,851	0,608	78,458°	6,134	2,00E-03	50
14	83,354°	0,28	-0,94	0,584	0,72	91,381°	3,143	4,20E-02	70
14	153,201°	0,382	-0,48	0,827	0,618	79,488°	4,816	7,00E-03	90
14	138,356°	0,435	-0,26	0,966	0,565	73,896°	7,58	3,80E-04	100
15	5,977°	0,525	0,10	1,227	0,475	65,06°	11,018	7,88E-06	40
15	281,283°	0,639	0,57	1,681	0,361	54,188°	16,353	2,25E-08	60
15	139,407°	0,189	-1,46	0,385	0,811	104,613°	1,426	2,41E-01	50
15	162,463°	0,234	-1,19	0,481	0,766	97,694°	2,185	1,12E-01	60
15	182,749°	0,15	-1,73	0,303	0,85	111,656°	0,897	4,10E-01	90
15	228,544°	0,103	-2,16	0,208	0,897	122,055°	0,428	6,55E-01	100
17	217,526°	0,16	-1,66	0,325	0,84	109,632°	1,028	3,60E-01	40

17	46,372°	0,139	-1,82	0,28	0,861	113,867°	0,771	4,66E-01	50
17	25,558°	0,271	-0,99	0,564	0,729	92,538°	2,946	5,20E-02	50
17	14,825°	0,081	-2,43	0,162	0,919	128,495°	0,262	7,72E-01	60
17	69,184°	0,145	-1,77	0,292	0,855	112,659°	0,837	4,35E-01	90
17	12,576°	0,285	-0,92	0,594	0,715	90,817°	3,243	3,80E-02	100
19	340,356°	0,077	-2,48	0,155	0,923	129,609°	0,24	7,89E-01	50
19	126,421°	0,225	-1,24	0,462	0,775	98,931°	2,029	1,31E-01	60
19	82,957°	0,169	-1,59	0,342	0,831	108,12°	1,136	3,23E-01	40
19	345,744°	0,088	-2,34	0,176	0,912	126,358°	0,309	7,37E-01	30
19	290,807°	0,086	-2,36	0,173	0,914	126,895°	0,296	7,46E-01	60
19	65,045°	0,096	-2,24	0,193	0,904	124,052°	0,368	6,95E-01	60
22	58,692°	0,523	0,09	1,223	0,477	65,208°	10,953	8,49E-06	40
22	133,313°	0,319	-0,76	0,673	0,681	86,648°	4,063	1,60E-02	40
22	105,678°	0,268	-1,00	0,556	0,732	92,977°	2,874	5,60E-02	80
22	173,632°	0,272	-0,98	0,566	0,728	92,422°	2,965	5,10E-02	80
22	169,566°	0,318	-0,76	0,672	0,682	86,681°	4,056	1,60E-02	60
22	62,209°	0,083	-2,40	0,166	0,917	127,92°	0,274	7,63E-01	70
25	260,457°	0,219	-1,27	0,449	0,781	99,877°	1,916	1,47E-01	70
25	82,338°	0,07	-2,59	0,141	0,93	132,006°	0,198	8,22E-01	100
25	254,03°	0,475	-0,10	1,078	0,525	69,888°	9,034	7,56E-05	70
25	166,292°	0,513	0,05	1,191	0,487	66,198°	10,527	1,39E-05	60
25	150,568°	0,231	-1,20	0,476	0,769	98,025°	2,142	1,17E-01	20
25	277,343°	0,673	0,72	1,85	0,327	51,007°	18,108	5,34E-09	85
26	72,69°	0,505	0,02	1,167	0,495	66,947°	10,213	1,99E-05	70
26	124,194°	0,13	-1,90	0,263	0,87	115,692°	0,678	5,10E-01	100
26	16,44°	0,627	0,52	1,622	0,373	55,403°	15,703	4,15E-08	70
26	54,831°	0,464	-0,14	1,047	0,536	70,955°	8,63	1,19E-04	50
26	50,775°	0,217	-1,28	0,444	0,783	100,173°	1,882	1,53E-01	20
26	110,421°	0,269	-1,00	0,558	0,731	92,874°	2,89	5,50E-02	85
30	93,949°	0,401	-0,40	0,875	0,599	77,455°	6,433	1,00E-03	70
30	70,642°	0,164	-1,63	0,333	0,836	108,899°	1,079	3,42E-01	100
30	122,67°	0,841	1,67	3,475	0,159	33,706°	28,298	2,75E-12	60
30	293,441°	0,205	-1,36	0,418	0,795	102,078°	1,673	1,88E-01	60
30	105,196°	0,217	-1,28	0,445	0,783	100,159°	1,883	1,52E-01	10
30	221,628°	0,594	0,38	1,483	0,406	58,524°	14,091	2,28E-07	90
31	193,376°	0,138	-1,83	0,278	0,862	114,108°	0,758	4,72E-01	70
31	3,675°	0,17	-1,59	0,345	0,83	107,836°	1,158	3,16E-01	100
31	283,049°	0,079	-2,46	0,159	0,921	128,95°	0,253	7,79E-01	60
31	348,102°	0,303	-0,83	0,635	0,697	88,574°	3,666	2,50E-02	80
31	354,795°	0,274	-0,97	0,571	0,726	92,14°	3,012	4,80E-02	30
31	324,93°	0,334	-0,69	0,71	0,666	84,808°	4,472	1,10E-02	80
32	318,65°	0,12	-1,99	0,241	0,88	118,027°	0,574	5,66E-01	80
32	8,76°	0,051	-2,92	0,102	0,949	139,775°	0,104	9,02E-01	100
32	11,777°	0,325	-0,73	0,688	0,675	85,886°	4,229	1,40E-02	60
32	181,76°	0,195	-1,42	0,397	0,805	103,626°	1,519	2,20E-01	80
32	141,14°	0,153	-1,71	0,31	0,847	110,947°	0,941	3,93E-01	20
32	347,012°	0,348	-0,63	0,743	0,652	83,226°	4,85	7,00E-03	85
33	314,517°	0,173	-1,56	0,351	0,827	107,36°	1,195	3,05E-01	80
33	35,068°	0,138	-1,83	0,278	0,862	114,121°	0,757	4,72E-01	100
33	69,264°	0,063	-2,70	0,126	0,937	134,724°	0,159	8,55E-01	60
33	64,407°	0,559	0,24	1,352	0,441	61,798°	12,498	1,41E-06	80
33	129,275°	0,107	-2,12	0,216	0,893	121,078°	0,46	6,34E-01	20
33	64,273°	0,035	-3,32	0,07	0,965	148,217°	0,05	9,52E-01	90
34	108,418°	0,242	-1,14	0,498	0,758	96,58°	2,334	9,60E-02	100
34	355,718°	0,109	-2,10	0,219	0,891	120,723°	0,472	6,27E-01	100
34	152,505°	0,468	-0,13	1,058	0,532	70,577°	8,772	1,02E-04	60
34	141,621°	0,28	-0,94	0,584	0,72	91,412°	3,138	4,20E-02	80
34	128,107°	0,484	-0,06	1,104	0,516	69,003°	9,379	5,13E-05	20
34	331,043°	0,076	-2,50	0,153	0,924	129,938°	0,234	7,94E-01	90
35	214,124°	0,161	-1,65	0,326	0,839	109,501°	1,037	3,57E-01	100
35	254,995°	0,283	-0,93	0,59	0,717	91,063°	3,199	4,00E-02	100
35	285,762°	0,479	-0,08	1,088	0,521	69,542°	9,168	6,51E-05	60
35	121,59°	0,14	-1,82	0,283	0,86	113,608°	0,784	4,59E-01	30
35	136,139°	0,262	-1,04	0,542	0,738	93,839°	2,736	6,40E-02	20
35	179,375°	0,333	-0,69	0,707	0,667	84,92°	4,447	1,10E-02	95
36	197,667°	0,267	-1,01	0,554	0,733	93,116°	2,851	5,70E-02	100
36	59,349°	0,259	-1,05	0,536	0,741	94,229°	2,675	6,80E-02	100
36	99,042°	0,09	-2,31	0,181	0,91	125,704°	0,325	7,25E-01	60
36	288,604°	0,141	-1,81	0,284	0,859	113,45°	0,793	4,55E-01	40
36	134,048°	0,315	-0,78	0,664	0,685	87,096°	3,967	1,80E-02	25

36	356,47°	0,13	-1,90	0,263	0,87	115,633°	0,681	5,09E-01	95
38	285,853°	0,736	1,03	2,255	0,264	44,814°	21,696	4,18E-10	100
38	324,298°	0,133	-1,87	0,269	0,867	115,047°	0,71	4,95E-01	100
38	276,589°	0,497	-0,01	1,142	0,503	67,749°	9,882	2,90E-05	70
38	273,685°	0,838	1,64	3,418	0,162	34,073°	28,085	3,27E-12	20
38	291,032°	0,095	-2,25	0,191	0,905	124,359°	0,36	7,00E-01	40
38	302,961°	0,447	-0,21	0,997	0,553	72,739°	7,982	2,44E-04	100
41	69,398°	0,586	0,35	1,452	0,414	59,259°	13,725	3,44E-07	100
41	258,618°	0,291	-0,89	0,609	0,709	89,966°	3,398	3,20E-02	90
41	209,607°	0,168	-1,60	0,34	0,832	108,3°	1,123	3,27E-01	70
41	68,113°	0,215	-1,30	0,44	0,785	100,492°	1,845	1,58E-01	30
41	164,94°	0,479	-0,08	1,088	0,521	69,532°	9,172	6,48E-05	60
41	337,262°	0,18	-1,52	0,365	0,82	106,186°	1,289	2,77E-01	95
42	142,6°	0,17	-1,59	0,345	0,83	107,826°	1,159	3,16E-01	100
42	176,174°	0,157	-1,68	0,317	0,843	110,305°	0,983	3,77E-01	80
42	134,489°	0,377	-0,50	0,814	0,623	80,043°	5,682	3,00E-03	70
42	95,675°	0,219	-1,27	0,449	0,781	99,879°	1,916	1,47E-01	10
42	120,745°	0,074	-2,53	0,148	0,926	130,831°	0,218	8,06E-01	60
42	86,487°	0,063	-2,70	0,126	0,937	134,837°	0,157	8,56E-01	95
44	13,911°	0,059	-2,77	0,119	0,941	136,178°	0,141	8,70E-01	60
44	103,472°	0,119	-2,00	0,239	0,881	118,252°	0,565	5,71E-01	20
45	175,415°	0,034	-3,35	0,067	0,966	149,218°	0,045	9,56E-01	5
45	34,935°	0,559	0,24	1,35	0,441	61,84°	12,478	1,45E-06	10
45	12,534°	0,516	0,06	1,2	0,484	65,916°	10,648	1,21E-05	20
45	333,772°	0,676	0,74	1,867	0,324	50,703°	18,279	4,70E-09	20
45	5,148°	0,433	-0,27	0,96	0,567	74,111°	7,507	4,12E-04	40
45	297,681°	0,328	-0,72	0,695	0,672	85,517°	4,311	1,30E-02	40
51	150,303°	0,16	-1,66	0,324	0,84	109,715°	1,022	3,62E-01	5
51	91,261°	0,188	-1,46	0,384	0,812	104,672°	1,421	2,43E-01	40
51	72,184°	0,203	-1,37	0,414	0,797	102,377°	1,642	1,94E-01	30
51	173,351°	0,174	-1,56	0,354	0,826	107,094°	1,216	2,98E-01	30
51	135,719°	0,121	-1,98	0,245	0,879	117,658°	0,59	5,57E-01	50
54	7,391°	0,246	-1,12	0,508	0,754	95,908°	2,428	8,80E-02	0
54	325,764°	0,365	-0,55	0,784	0,635	81,353°	5,327	4,00E-03	20
54	108,535°	0,342	-0,65	0,727	0,658	83,984°	4,666	9,00E-03	10
54	131,819°	0,328	-0,72	0,695	0,672	85,54°	4,306	1,30E-02	30
54	175,726°	0,304	-0,83	0,638	0,696	88,45°	3,69	2,40E-02	50
54	42,101°	0,073	-2,54	0,147	0,927	131,023°	0,214	8,09E-01	50
54	69,526°	0,226	-1,23	0,465	0,774	98,753°	2,051	1,29E-01	50
55	187,79°	0,797	1,37	2,824	0,203	38,614°	25,398	2,70E-11	5
55	16,259°	0,529	0,12	1,24	0,471	64,662°	11,192	6,44E-06	10
55	57,812°	0,365	-0,55	0,785	0,635	81,305°	5,34	4,00E-03	5
55	86,835°	0,306	-0,82	0,643	0,694	88,19°	3,742	2,30E-02	15
55	329,22°	0,429	-0,29	0,95	0,571	74,52°	7,369	4,79E-04	30
56	74,163°	0,428	-0,29	0,947	0,572	74,61°	7,339	4,95E-04	5
56	173,886°	0,375	-0,51	0,81	0,625	80,199°	5,638	3,00E-03	10
56	213,496°	0,516	0,06	1,199	0,484	65,941°	10,637	1,22E-05	5
56	95,846°	0,16	-1,66	0,323	0,84	109,761°	1,019	3,63E-01	10
56	198,207°	0,092	-2,29	0,184	0,908	125,202°	0,338	7,16E-01	30
56	283,858°	0,124	-1,96	0,251	0,876	116,988°	0,619	5,42E-01	50
60	216,913°	0,827	1,56	3,231	0,173	35,347°	27,338	5,93E-12	10
60	293,908°	0,815	1,48	3,058	0,185	36,644°	26,572	1,09E-11	0
60	310,171°	0,699	0,84	1,998	0,301	48,518°	19,528	1,92E-09	15
60	268,444°	0,72	0,94	2,137	0,28	46,436°	20,74	8,22E-10	20
60	246,848°	0,128	-1,92	0,258	0,872	116,168°	0,656	5,22E-01	30
60	256,197°	0,051	-2,92	0,103	0,949	139,607°	0,106	9,01E-01	30
61	168,185°	0,271	-0,99	0,562	0,729	92,63°	2,93	5,20E-02	10
61	68,314°	0,255	-1,07	0,527	0,745	94,748°	2,597	7,40E-02	0
61	11,25°	0,101	-2,19	0,202	0,899	122,807°	0,404	6,70E-01	15
61	327,009°	0,292	-0,89	0,61	0,708	89,938°	3,404	3,20E-02	20
62	98,285°	0,766	1,19	2,506	0,234	41,792°	23,496	1,13E-10	10
62	161,09°	0,811	1,46	3,004	0,189	37,071°	26,318	1,32E-11	0
62	167,61°	0,981	3,94	26,544	0,019	11,229°	38,493	<1E-12	10
62	164,632°	0,155	-1,70	0,314	0,845	110,646°	0,96	3,85E-01	20
62	219,229°	0,342	-0,65	0,729	0,658	83,901°	4,686	8,00E-03	30
62	232,034°	0,203	-1,37	0,414	0,797	102,374°	1,643	1,94E-01	50
63	113,763°	0,238	-1,16	0,489	0,762	97,149°	2,257	1,04E-01	20
63	323,838°	0,589	0,36	1,465	0,411	58,957°	13,875	2,90E-07	10
63	315,213°	0,431	-0,28	0,955	0,569	74,316°	7,437	4,44E-04	5
63	319,938°	0,354	-0,60	0,757	0,646	82,589°	5,008	6,00E-03	20

63	30,177°	0,274	-0,97	0,57	0,726	92,172°	3,007	4,80E-02	40
63	68,854°	0,187	-1,47	0,38	0,813	104,978°	1,394	2,50E-01	30
65	230,289°	0,611	0,45	1,557	0,389	56,828°	14,956	8,87E-08	5
65	98,654°	0,84	1,66	3,455	0,16	33,832°	28,225	2,92E-12	20
65	82,715°	0,684	0,77	1,91	0,316	49,964°	18,698	3,46E-09	30
65	112,895°	0,661	0,67	1,789	0,339	52,106°	17,494	8,57E-09	30
65	142,668°	0,423	-0,31	0,932	0,577	75,197°	7,145	6,12E-04	50
65	212,261°	0,429	-0,29	0,948	0,571	74,564°	7,354	4,87E-04	50
159	146,469°	0,783	1,28	2,666	0,217	40,113°	24,502	5,34E-11	20
159	253,504°	0,105	-2,14	0,211	0,895	121,703°	0,439	6,47E-01	40
159	233,848°	0,565	0,26	1,374	0,435	61,21°	12,776	1,02E-06	80
159	160,721°	0,564	0,26	1,369	0,436	61,339°	12,715	1,10E-06	80
159	161,611°	0,269	-1,00	0,558	0,731	92,859°	2,893	5,50E-02	80
159	113,376°	0,352	-0,61	0,752	0,648	82,787°	4,959	6,00E-03	65
160	46,694°	0,673	0,72	1,848	0,327	51,027°	18,097	5,38E-09	80
160	103,584°	0,308	-0,81	0,647	0,692	87,94°	3,793	2,20E-02	60
160	246,116°	0,232	-1,20	0,477	0,768	97,93°	2,154	1,16E-01	80
160	169,819°	0,353	-0,61	0,755	0,647	82,671°	4,988	6,00E-03	80
160	317,641°	0,131	-1,89	0,264	0,869	115,579°	0,684	5,08E-01	80
160	30,16°	0,247	-1,11	0,51	0,753	95,815°	2,441	8,60E-02	65
161	166,795°	0,359	-0,58	0,77	0,641	81,999°	5,159	5,00E-03	80
161	67,232°	0,519	0,08	1,211	0,481	65,578°	10,793	1,02E-05	60
161	224,586°	0,124	-1,96	0,249	0,876	117,155°	0,611	5,46E-01	70
161	45,352°	0,152	-1,72	0,307	0,848	111,302°	0,919	4,02E-01	80
161	77,573°	0,4	-0,41	0,872	0,6	77,588°	6,392	1,00E-03	80
161	331,595°	0,232	-1,20	0,477	0,768	97,92°	2,156	1,16E-01	65
162	342,203°	0,639	0,57	1,682	0,361	54,182°	16,356	2,24E-08	70
162	49,964°	0,716	0,92	2,112	0,284	46,793°	20,53	9,52E-10	60
162	156,581°	0,488	-0,05	1,114	0,512	68,669°	9,511	4,42E-05	70
162	285,637°	0,133	-1,87	0,268	0,867	115,114°	0,706	4,96E-01	70
162	348,726°	0,417	-0,34	0,917	0,583	75,767°	6,96	7,48E-04	60
163	94,687°	0,647	0,61	1,718	0,353	53,457°	16,75	1,58E-08	80
163	157,053°	0,627	0,52	1,623	0,373	55,398°	15,706	4,14E-08	70
163	112,196°	0,457	-0,17	1,027	0,543	71,658°	8,37	1,59E-04	70
163	199,475°	0,326	-0,73	0,689	0,674	85,812°	4,245	1,30E-02	60
163	123,818°	0,174	-1,56	0,354	0,826	107,106°	1,215	2,99E-01	60
163	91,644°	0,267	-1,01	0,554	0,733	93,104°	2,853	5,70E-02	65
164	346,882°	0,164	-1,63	0,333	0,836	108,919°	1,078	3,42E-01	90
164	19,271°	0,302	-0,84	0,634	0,698	88,663°	3,648	2,50E-02	60
164	73,405°	0,106	-2,13	0,213	0,894	121,354°	0,451	6,40E-01	60
164	166,037°	0,113	-2,06	0,228	0,887	119,631°	0,511	6,03E-01	60
164	136,879°	0,213	-1,31	0,436	0,787	100,772°	1,814	1,63E-01	60
164	110,388°	0,241	-1,15	0,498	0,759	96,592°	2,332	9,70E-02	65
165	7,06°	0,627	0,52	1,624	0,373	55,367°	15,722	4,07E-08	70
165	138,342°	0,413	-0,35	0,906	0,587	76,205°	6,82	8,70E-04	80
165	99,372°	0,19	-1,45	0,387	0,81	104,416°	1,444	2,37E-01	60
165	142,907°	0,268	-1,00	0,555	0,732	93,036°	2,864	5,60E-02	60
165	143,371°	0,454	-0,18	1,018	0,546	71,991°	8,249	1,82E-04	60
165	259,972°	0,117	-2,02	0,236	0,883	118,695°	0,547	5,81E-01	65
166	170,156°	0,453	-0,19	1,016	0,547	72,069°	8,221	1,87E-04	80
166	237,974°	0,443	-0,23	0,989	0,557	73,064°	7,867	2,77E-04	60
166	161,201°	0,619	0,49	1,588	0,381	56,134°	15,318	6,10E-08	60
166	78,75°	0,553	0,21	1,329	0,447	62,397°	12,218	1,96E-06	60
166	91,911°	0,538	0,15	1,279	0,462	63,792°	11,58	4,11E-06	60
166	69,504°	0,393	-0,43	0,855	0,607	78,272°	6,188	2,00E-03	65
167	118,329°	0,481	-0,08	1,095	0,519	69,324°	9,253	5,91E-05	70
167	350,858°	0,196	-1,41	0,4	0,804	103,456°	1,535	2,16E-01	70
167	228,908°	0,18	-1,52	0,366	0,82	106,134°	1,294	2,76E-01	60
167	38,522°	0,173	-1,56	0,351	0,827	107,391°	1,192	3,05E-01	60
167	134,526°	0,33	-0,71	0,699	0,67	85,311°	4,357	1,20E-02	60
167	125,532°	0,182	-1,50	0,37	0,818	105,767°	1,325	2,67E-01	60
168	148,505°	0,207	-1,34	0,423	0,793	101,731°	1,71	1,81E-01	60
168	307,796°	0,098	-2,22	0,196	0,902	123,56°	0,382	6,85E-01	70
168	262,951°	0,324	-0,74	0,685	0,676	86,016°	4,2	1,40E-02	70
168	339,672°	0,13	-1,90	0,262	0,87	115,772°	0,674	5,12E-01	60
168	153,503°	0,116	-2,03	0,233	0,884	118,966°	0,537	5,88E-01	45
168	21,903°	0,569	0,28	1,388	0,431	60,867°	12,94	8,47E-07	25
169	341,157°	0,272	-0,98	0,565	0,728	92,482°	2,955	5,10E-02	60
169	16,122°	0,337	-0,68	0,717	0,663	84,461°	4,553	1,00E-02	50
169	288,261°	0,297	-0,86	0,623	0,703	89,234°	3,537	2,80E-02	70

169	166,078°	0,569	0,28	1,39	0,431	60,82°	12,963	8,25E-07	60
169	175,866°	0,393	-0,43	0,856	0,607	78,265°	6,19	2,00E-03	40
169	165,975°	0,063	-2,70	0,125	0,937	134,882°	0,157	8,56E-01	20
170	134,588°	0,405	-0,38	0,885	0,595	77,038°	6,56	1,00E-03	60
170	65,738°	0,578	0,31	1,423	0,422	59,966°	13,377	5,12E-07	70
170	144,591°	0,317	-0,77	0,669	0,683	86,808°	4,028	1,70E-02	70
170	33,496°	0,151	-1,73	0,306	0,849	111,405°	0,912	4,04E-01	60
170	74,186°	0,24	-1,15	0,494	0,76	96,836°	2,299	1,00E-01	40
170	348,75°	0,028	-3,55	0,056	0,972	153,388°	0,031	9,70E-01	20
171	11,389°	0,149	-1,74	0,302	0,851	111,736°	0,892	4,12E-01	70
171	334,634°	0,16	-1,66	0,324	0,84	109,724°	1,022	3,62E-01	70
171	183,492°	0,196	-1,41	0,399	0,804	103,499°	1,531	2,17E-01	70
171	123,854°	0,17	-1,59	0,345	0,83	107,874°	1,155	3,17E-01	60
171	200,279°	0,231	-1,20	0,475	0,769	98,046°	2,14	1,17E-01	45
171	281,514°	0,067	-2,63	0,134	0,933	133,271°	0,179	8,38E-01	20
172	338,461°	0,082	-2,42	0,165	0,918	128,13°	0,269	7,66E-01	60
172	149,918°	0,104	-2,15	0,209	0,896	121,916°	0,432	6,52E-01	70
172	109,72°	0,065	-2,67	0,131	0,935	133,792°	0,171	8,44E-01	70
172	359,123°	0,148	-1,75	0,3	0,852	111,946°	0,879	4,18E-01	80
172	334,076°	0,187	-1,47	0,381	0,813	104,887°	1,402	2,47E-01	45
172	152,339°	0,327	-0,72	0,692	0,673	85,677°	4,275	1,30E-02	10
173	232,146°	0,507	0,03	1,173	0,493	66,769°	10,287	1,83E-05	60
173	127,004°	0,306	-0,82	0,642	0,694	88,203°	3,74	2,30E-02	60
173	46,511°	0,163	-1,64	0,331	0,837	109,098°	1,065	3,47E-01	70
173	345,97°	0,127	-1,93	0,256	0,873	116,425°	0,644	5,28E-01	70
173	242,792°	0,327	-0,72	0,692	0,673	85,69°	4,272	1,30E-02	45
173	54,626°	0,046	-3,03	0,093	0,954	142,063°	0,086	9,19E-01	10
174	332,552°	0,792	1,34	2,768	0,208	39,126°	25,092	3,41E-11	60
174	349,359°	0,639	0,57	1,681	0,361	54,186°	16,354	2,25E-08	70
174	274,435°	0,231	-1,20	0,475	0,769	98,083°	2,135	1,18E-01	70
174	237,114°	0,116	-2,03	0,234	0,884	118,899°	0,539	5,86E-01	70
174	18,542°	0,449	-0,20	1,005	0,551	72,465°	8,079	2,19E-04	45
174	84,361°	0,097	-2,23	0,195	0,903	123,786°	0,376	6,89E-01	20

Table S3. Raw data time-shift sun compass group

Fish #	Mean Vector(µ)	corrected mean vector (15°/h) - in °	corrected mean vector (actual) - in °	Length of Mean Vector(r)	Concen -tration	Circular Variance	Circular Standard Deviation	Rayleigh Test(Z)	Rayleigh Test(p)	Cloudiness
66	311,685°	41,685°	44,725°	0,411	0,901	0,589	76,406°	6,757	9,32E-04	30
66	73,745°	163,745°	176,979°	0,418	0,921	0,582	75,627°	7,005	7,12E-04	10
66	65,859°	155,859°	178,119°	0,145	0,293	0,855	112,629°	0,839	4,35E-01	30
66	3,022°	93,022°	121,109°	0,628	1,629	0,372	55,268°	15,775	3,87E-08	10
66	338,66°	68,66°	98,797°	0,351	0,749	0,649	82,94°	4,92	7,00E-03	10
66	68,039°	158,039°	186,071°	0,191	0,39	0,809	104,209°	1,464	2,33E-01	10
67	41,535°	131,535°	134,763°	0,487	1,113	0,513	68,705°	9,497	4,49E-05	40
67	100,679°	190,679°	204,102°	0,25	0,517	0,75	95,365°	2,506	8,10E-02	10
67	3,38°	93,38°	115,785°	0,355	0,759	0,645	82,461°	5,041	6,00E-03	30
67	350,544°	80,544°	108,707°	0,174	0,354	0,826	107,114°	1,214	2,99E-01	10
67	141,831°	231,831°	261,966°	0,306	0,644	0,694	88,129°	3,755	2,20E-02	10
68	73,776°	163,776°	167,191°	0,644	1,701	0,356	53,783°	16,572	1,85E-08	40
68	28,078°	118,078°	131,501°	0,221	0,453	0,779	99,599°	1,949	1,43E-01	20
68	356,656°	86,656°	109,061°	0,454	1,017	0,546	72,042°	8,231	1,85E-04	25
68	35,062°	125,062°	153,373°	0,561	1,36	0,439	61,583°	12,599	1,26E-06	10
68	214,574°	304,574°	334,706°	0,061	0,122	0,939	135,545°	0,148	8,64E-01	20
68	198,794°	288,794°	316,668°	0,225	0,462	0,775	98,972°	2,024	1,32E-01	10
69	92,396°	182,396°	186,°	0,241	0,498	0,759	96,589°	2,333	9,70E-02	40
69	52,13°	142,13°	155,742°	0,611	1,553	0,389	56,915°	14,912	9,30E-08	20
69	339,881°	69,881°	92,429°	0,183	0,371	0,817	105,674°	1,333	2,65E-01	25
69	205,463°	295,463°	323,846°	0,11	0,221	0,89	120,411°	0,483	6,20E-01	10
69	53,533°	143,533°	173,665°	0,366	0,787	0,634	81,219°	5,363	4,00E-03	20
69	45,26°	135,26°	162,713°	0,006	0,012	0,994	182,664°	0,002	9,98E-01	10
70	214,312°	304,312°	307,916°	0,684	1,911	0,316	49,943°	18,71	3,43E-09	40
70	261,099°	351,099°	4,899°	0,907	5,661	0,093	25,323°	32,902	<1E-12	20
70	11,2°	101,2°	124,031°	0,355	0,76	0,645	82,438°	5,046	6,00E-03	30
70	320,173°	50,173°	78,626°	0,492	1,128	0,508	68,2°	9,699	3,57E-05	5

70	230,43°	320,43°	350,557°	0,178	0,363	0,822	106,371°	1,274	2,81E-01	20
71	317,569°	47,569°	51,361°	0,441	0,982	0,559	73,314°	7,78	3,05E-04	40
71	29,202°	119,202°	133,376°	0,797	2,826	0,203	38,595°	25,41	2,68E-11	20
71	318,475°	48,475°	71,446°	0,38	0,823	0,62	79,66°	5,789	3,00E-03	30
71	359,12°	89,12°	117,71°	0,093	0,187	0,907	124,88°	0,346	7,10E-01	5
71	272,528°	2,528°	32,641°	0,21	0,43	0,79	101,177°	1,769	1,71E-01	20
72	40,69°	130,69°	134,672°	0,242	0,499	0,758	96,537°	2,34	9,60E-02	40
72	283,458°	13,458°	27,819°	0,051	0,103	0,949	139,585°	0,106	9,01E-01	20
72	120,753°	210,753°	233,862°	0,2	0,408	0,8	102,802°	1,599	2,03E-01	30
72	337,653°	67,653°	96,309°	0,108	0,218	0,892	120,76°	0,471	6,27E-01	5
72	42,771°	132,771°	162,875°	0,266	0,552	0,734	93,211°	2,836	5,80E-02	20
73	26,241°	116,241°	120,412°	0,88	4,457	0,12	29,007°	30,956	<1E-12	40
73	53,087°	143,087°	157,634°	0,786	2,698	0,214	39,804°	24,686	4,65E-11	20
73	47,608°	137,608°	160,855°	0,553	1,329	0,447	62,403°	12,215	1,97E-06	30
73	5,476°	95,476°	124,26°	0,155	0,314	0,845	110,619°	0,962	3,84E-01	5
73	307,583°	37,583°	67,664°	0,174	0,353	0,826	107,215°	1,206	3,01E-01	20
74	174,801°	264,801°	269,162°	0,221	0,454	0,779	99,491°	1,961	1,41E-01	40
74	241,775°	331,775°	346,507°	0,959	12,494	0,041	16,556°	36,796	<1E-12	30
74	347,63°	77,63°	101,148°	0,432	0,958	0,568	74,219°	7,47	4,29E-04	30
74	105,336°	195,336°	224,182°	0,025	0,05	0,975	155,493°	0,025	9,75E-01	5
74	273,35°	3,35°	33,417°	0,038	0,077	0,962	146,288°	0,059	9,43E-01	30
74	270,144°	,144°	26,852°	0,062	0,125	0,938	134,995°	0,155	8,58E-01	10
75	51,671°	141,671°	146,223°	0,636	1,664	0,364	54,545°	16,161	2,68E-08	50
75	130,964°	220,964°	236,065°	0,889	4,813	0,111	27,753°	31,635	<1E-12	40
75	136,077°	226,077°	249,861°	0,94	8,626	0,06	20,132°	35,354	<1E-12	15
75	153,658°	243,658°	272,564°	0,269	0,558	0,731	92,857°	2,893	5,40E-02	5
75	61,257°	151,257°	181,293°	0,084	0,168	0,916	127,667°	0,279	7,59E-01	30
75	146,25°	236,25°	262,758°	0,057	0,114	0,943	137,273°	0,129	8,81E-01	0
76	90,246°	180,246°	188,271°	0,759	2,442	0,241	42,523°	23,059	1,56E-10	50
76	311,036°	41,036°	58,993°	0,226	0,464	0,774	98,825°	2,042	1,30E-01	40
76	314,224°	44,224°	69,73°	0,764	2,488	0,236	41,995°	23,375	1,24E-10	5
76	52,354°	142,354°	171,994°	0,234	0,482	0,766	97,63°	2,193	1,11E-01	5
76	124,975°	214,975°	244,588°	0,041	0,082	0,959	144,842°	0,067	9,36E-01	30
77	195,828°	285,828°	294,048°	0,27	0,561	0,73	92,691°	2,92	5,30E-02	40
77	82,98°	172,98°	191,109°	0,42	0,924	0,58	75,52°	7,04	6,86E-04	30
77	172,547°	262,547°	288,278°	0,827	3,243	0,173	35,261°	27,389	5,69E-12	5
77	180,314°	270,314°	299,991°	0,17	0,344	0,83	107,926°	1,151	3,18E-01	5
78	,97°	90,97°	99,384°	0,391	0,849	0,609	78,548°	6,107	2,00E-03	40
78	38,68°	128,68°	146,98°	0,279	0,581	0,721	91,537°	3,116	4,30E-02	40
78	121,364°	211,364°	237,315°	0,458	1,029	0,542	71,591°	8,395	1,54E-04	5
78	140,16°	230,16°	259,873°	0,313	0,66	0,687	87,298°	3,925	1,90E-02	5
78	189,068°	279,068°	308,557°	0,258	0,534	0,742	94,306°	2,664	6,90E-02	30
79	25,639°	115,639°	124,248°	0,873	4,255	0,127	29,802°	30,519	<1E-12	40
79	155,896°	245,896°	264,196°	0,346	0,737	0,654	83,517°	4,779	8,00E-03	30
79	181,493°	271,493°	297,552°	0,158	0,319	0,842	110,155°	0,993	3,73E-01	5
79	90,477°	180,477°	210,224°	0,131	0,263	0,869	115,612°	0,682	5,08E-01	5
79	99,883°	189,883°	219,187°	0,261	0,541	0,739	93,896°	2,727	6,50E-02	20
79	109,769°	199,769°	224,604°	0,039	0,077	0,961	146,193°	0,06	9,43E-01	0
80	56,387°	146,387°	155,19°	0,419	0,921	0,581	75,607°	7,012	7,07E-04	40
80	296,716°	26,716°	45,186°	0,678	1,879	0,322	50,496°	18,396	4,31E-09	30
80	34,219°	124,219°	150,385°	0,795	2,807	0,205	38,766°	25,308	2,89E-11	10
80	67,848°	157,848°	187,628°	0,056	0,113	0,944	137,478°	0,126	8,83E-01	5
81	302,156°	32,156°	41,154°	0,9	5,298	0,1	26,281°	32,411	<1E-12	40
81	242,416°	332,416°	351,055°	0,238	0,49	0,762	97,072°	1,53	2,18E-01	20
82	10,335°	100,335°	109,527°	0,399	0,87	0,601	77,66°	6,371	1,00E-03	40
82	46,198°	136,198°	155,173°	0,64	1,683	0,36	54,153°	16,372	2,21E-08	20
82	38,71°	128,71°	155,187°	0,648	1,72	0,352	53,415°	16,773	1,55E-08	5
82	7,316°	97,316°	127,187°	0,105	0,211	0,895	121,641°	0,441	6,46E-01	5
83	266,165°	356,165°	5,551°	0,452	1,012	0,548	72,199°	8,174	1,97E-04	30
83	306,108°	36,108°	55,25°	0,779	2,624	0,221	40,543°	24,244	6,49E-11	20
83	315,994°	45,994°	72,672°	0,607	1,54	0,393	57,214°	14,757	1,10E-07	5
83	309,918°	39,918°	69,842°	0,645	1,71	0,355	53,61°	16,666	1,70E-08	5
83	130,002°	220,002°	248,985°	0,251	0,518	0,749	95,332°	2,51	8,10E-02	20
84	18,73°	108,73°	118,311°	0,671	1,841	0,329	51,162°	18,021	5,70E-09	30
84	218,484°	308,484°	327,791°	0,422	0,931	0,578	75,239°	7,131	6,21E-04	20
84	149,417°	239,417°	266,194°	0,231	0,474	0,769	98,127°	2,129	1,19E-01	5
85	4,948°	94,948°	104,917°	0,576	1,415	0,424	60,185°	13,27	5,79E-07	30
85	324,631°	54,631°	74,267°	0,579	1,425	0,421	59,939°	13,39	5,04E-07	15
85	303,984°	33,984°	60,858°	0,774	2,58	0,226	41,001°	23,97	7,97E-11	5
85	281,905°	11,905°	41,897°	0,462	1,04	0,538	71,223°	8,53	1,33E-04	5

85	123,8°	213,8°	242,603°	0,353	0,754	0,647	82,72°	4,975	6,00E-03	20
85	199,201°	289,201°	312,624°	0,109	0,219	0,891	120,628°	0,475	6,24E-01	5
86	20,561°	110,561°	140,403°	0,425	0,939	0,575	74,94°	7,229	5,58E-04	5
86	92,733°	182,733°	211,883°	0,376	0,812	0,624	80,108°	5,664	3,00E-03	20
86	214,322°	304,322°	328,911°	0,131	0,265	0,869	115,452°	0,69	5,05E-01	5
86	4,921°	94,921°	115,563°	0,328	0,695	0,672	85,548°	4,304	1,30E-02	10
86	198,31°	288,31°	304,375°	0,043	0,086	0,957	143,76°	0,074	9,30E-01	15
86	164,789°	254,789°	265,585°	0,536	1,272	0,464	63,975°	11,498	4,52E-06	15
88	120,811°	210,811°	214,508°	0,405	0,886	0,595	77,022°	6,565	1,00E-03	20
88	29,535°	119,535°	133,309°	0,705	2,038	0,295	47,893°	19,889	1,49E-09	5
88	21,807°	111,807°	134,595°	0,671	1,838	0,329	51,218°	17,989	5,84E-09	0
88	178,55°	268,55°	296,686°	0,623	1,608	0,377	55,715°	15,538	4,88E-08	30
88	338,103°	68,103°	97,769°	0,121	0,243	0,879	117,794°	0,584	5,61E-01	50
88	206,358°	296,358°	323,23°	0,078	0,157	0,922	129,35°	0,245	7,85E-01	40
90	357,81°	87,81°	91,695°	0,607	1,54	0,393	57,206°	14,761	1,09E-07	20
90	32,06°	122,06°	136,203°	0,301	0,631	0,699	88,779°	3,625	2,60E-02	10
90	90,92°	180,92°	203,843°	0,123	0,249	0,877	117,194°	0,61	5,46E-01	5
90	190,259°	280,259°	308,653°	0,327	0,693	0,673	85,632°	4,285	1,30E-02	0
90	201,155°	291,155°	320,792°	0,391	0,85	0,609	78,486°	6,125	2,00E-03	40
90	42,014°	132,014°	158,703°	0,18	0,367	0,82	106,043°	1,301	2,74E-01	40
91	28,104°	118,104°	122,176°	0,888	4,742	0,112	27,989°	31,508	<1E-12	20
91	170,357°	260,357°	274,684°	0,377	0,813	0,623	80,076°	5,673	3,00E-03	10
91	65,671°	155,671°	178,729°	0,291	0,609	0,709	89,967°	3,398	3,20E-02	0
91	28,987°	118,987°	147,502°	0,552	1,326	0,448	62,48°	12,179	2,05E-06	5
91	336,095°	66,095°	95,697°	0,773	2,566	0,227	41,147°	23,882	8,51E-11	30
91	263,649°	353,649°	20,245°	0,212	0,434	0,788	100,934°	1,796	1,66E-01	40
92	56,25°	146,25°	150,322°	0,966	14,906	0,034	15,103°	37,315	<1E-12	20
92	87,235°	177,235°	191,928°	0,992	60,057	0,008	7,425°	39,334	<1E-12	10
92	83,591°	173,591°	196,914°	0,775	2,592	0,225	40,876°	24,045	7,53E-11	0
92	131,362°	221,362°	249,935°	0,281	0,586	0,719	91,288°	3,159	4,10E-02	5
92	7,209°	97,209°	126,792°	0,484	1,103	0,516	69,027°	9,37	5,18E-05	30
93	290,225°	20,225°	24,485°	0,262	0,542	0,738	93,811°	2,74	6,40E-02	20
93	43,045°	133,045°	147,92°	0,187	0,382	0,813	104,85°	1,405	2,47E-01	10
93	120,21°	210,21°	233,794°	0,437	0,97	0,563	73,751°	7,629	3,60E-04	10
93	241,631°	331,631°	,316°	0,068	0,137	0,932	132,703°	0,187	8,31E-01	5
93	294,705°	24,705°	54,244°	0,142	0,287	0,858	113,245°	0,804	4,50E-01	25
93	11,735°	101,735°	128,043°	0,088	0,176	0,912	126,414°	0,308	7,38E-01	60
94	59,423°	149,423°	153,871°	0,135	0,272	0,865	114,69°	0,728	4,86E-01	20
94	68,239°	158,239°	173,295°	0,162	0,328	0,838	109,341°	1,048	3,53E-01	10
94	280,009°	10,009°	33,722°	0,887	4,713	0,113	28,088°	31,455	<1E-12	10
94	322,049°	52,049°	80,788°	0,532	1,258	0,468	64,366°	11,323	5,54E-06	5
94	353,986°	83,986°	113,502°	0,202	0,413	0,798	102,433°	1,637	1,95E-01	25
94	161,166°	251,166°	277,275°	0,252	0,521	0,748	95,124°	2,541	7,80E-02	60
96	81,588°	171,588°	195,679°	0,329	0,697	0,671	85,437°	4,329	1,20E-02	10
96	253,884°	343,884°	12,777°	0,135	0,272	0,865	114,708°	0,727	4,86E-01	10
96	25,121°	115,121°	144,527°	0,432	0,956	0,568	74,281°	7,449	4,39E-04	20
96	37,089°	127,089°	152,994°	0,365	0,784	0,635	81,345°	5,329	4,00E-03	40
98	127,776°	217,776°	226,619°	0,568	1,384	0,432	60,975°	12,888	8,99E-07	20
98	126,767°	216,767°	235,304°	0,294	0,615	0,706	89,645°	3,459	3,00E-02	15
98	218,98°	308,98°	334,892°	0,507	1,174	0,493	66,738°	10,3	1,80E-05	0
98	153,684°	243,684°	273,201°	0,199	0,407	0,801	102,895°	1,59	2,05E-01	90
98	226,507°	316,507°	345,295°	0,293	0,612	0,707	89,811°	3,428	3,10E-02	30
98	334,349°	64,349°	88,431°	0,226	0,465	0,774	98,762°	2,05	1,29E-01	60
100	85,497°	175,497°	184,725°	0,142	0,286	0,858	113,259°	0,804	4,50E-01	20
100	114,316°	204,316°	223,018°	0,171	0,347	0,829	107,686°	1,169	3,12E-01	10
100	344,733°	74,733°	101,048°	0,282	0,589	0,718	91,129°	3,187	4,00E-02	20
100	27,956°	117,956°	147,497°	0,449	1,003	0,551	72,525°	8,058	2,25E-04	70
100	,325°	90,325°	119,007°	0,317	0,67	0,683	86,797°	4,031	1,70E-02	30
100	22,°	112,°	135,831°	0,262	0,542	0,738	93,832°	2,737	6,40E-02	65
103	47,16°	137,16°	146,963°	0,809	2,978	0,191	37,285°	26,191	1,46E-11	40
103	139,559°	229,559°	248,914°	0,405	0,886	0,595	76,998°	6,573	1,00E-03	20
103	152,388°	242,388°	269,083°	0,479	1,09	0,521	69,48°	9,192	6,33E-05	10
103	107,852°	197,852°	227,474°	0,533	1,262	0,467	64,265°	11,368	5,26E-06	70
103	55,553°	145,553°	173,943°	0,108	0,217	0,892	120,941°	0,465	6,31E-01	25
103	82,634°	172,634°	195,948°	0,183	0,372	0,817	105,626°	1,337	2,64E-01	70
104	225,948°	315,948°	326,135°	0,288	0,602	0,712	90,361°	3,326	3,50E-02	40
104	175,719°	265,719°	285,235°	0,894	5,021	0,106	27,092°	31,986	<1E-12	20
104	96,697°	186,697°	213,575°	0,719	2,132	0,281	46,501°	20,701	8,44E-10	10
104	237,226°	327,226°	356,879°	0,395	0,859	0,605	78,141°	6,227	2,00E-03	60
104	328,074°	58,074°	86,402°	0,603	1,523	0,397	57,597°	14,561	1,36E-07	25

104	38,799°	128,799°	151,847°	0,233	0,48	0,767	97,775°	2,174	1,13E-01	70
106	245,947°	335,947°	346,707°	0,716	2,107	0,284	46,866°	20,488	9,81E-10	20
106	219,535°	309,535°	329,051°	0,705	2,04	0,295	47,877°	19,898	1,48E-09	15
106	295,759°	25,759°	52,813°	0,146	0,295	0,854	112,416°	0,852	4,29E-01	10
106	272,932°	2,932°	32,622°	0,333	0,705	0,667	85,025°	4,423	1,10E-02	50
106	10,514°	100,514°	128,645°	0,126	0,254	0,874	116,621°	0,635	5,33E-01	25
118	34,743°	124,743°	129,457°	0,652	1,742	0,348	52,982°	17,01	1,27E-08	0
118	105,63°	195,63°	209,338°	0,151	0,305	0,849	111,478°	0,908	4,06E-01	20
118	341,09°	71,09°	91,713°	0,139	0,281	0,861	113,818°	0,773	4,64E-01	20
118	33,504°	123,504°	148,01°	0,089	0,178	0,911	126,157°	0,314	7,33E-01	0
118	238,446°	328,446°	353,121°	0,305	0,641	0,695	88,277°	3,725	2,30E-02	0
118	280,365°	10,365°	31,07°	0,218	0,447	0,782	99,988°	1,903	1,49E-01	0
119	175,134°	265,134°	270,016°	0,115	0,231	0,885	119,254°	0,526	5,94E-01	0
119	269,411°	359,411°	13,271°	0,061	0,123	0,939	135,324°	0,151	8,61E-01	20
119	224,614°	314,614°	335,341°	0,271	0,563	0,729	92,572°	2,94	5,20E-02	20
119	54,464°	144,464°	169,008°	0,209	0,428	0,791	101,364°	1,749	1,74E-01	0
119	162,709°	252,709°	277,351°	0,204	0,416	0,796	102,192°	1,661	1,91E-01	0
119	325,426°	55,426°	76,131°	0,086	0,173	0,914	126,874°	0,297	7,46E-01	0
120	53,085°	143,085°	147,967°	0,888	4,773	0,112	27,886°	31,563	<1E-12	0
120	54,46°	144,46°	158,32°	0,822	3,152	0,178	35,923°	26,998	7,76E-12	20
120	57,988°	147,988°	168,817°	0,871	4,178	0,129	30,125°	30,339	<1E-12	0
120	19,317°	109,317°	133,897°	0,221	0,454	0,779	99,49°	1,962	1,41E-01	0
120	40,158°	130,158°	154,766°	0,209	0,428	0,791	101,313°	1,755	1,73E-01	0
120	331,04°	61,04°	81,536°	0,232	0,477	0,768	97,926°	2,155	1,16E-01	0
121	64,131°	154,131°	159,18°	0,579	1,428	0,421	59,863°	13,427	4,83E-07	0
121	235,035°	325,035°	345,966°	0,442	0,985	0,558	73,192°	7,823	2,91E-04	0
121	91,829°	181,829°	202,76°	0,892	4,932	0,108	27,368°	31,84	<1E-12	20
121	70,254°	160,254°	184,869°	0,834	3,346	0,166	34,55°	27,806	4,08E-12	0
121	91,35°	181,35°	205,923°	0,866	4,039	0,134	30,731°	30	<1E-12	0
121	111,479°	201,479°	221,869°	0,854	3,732	0,146	32,218°	29,157	<1E-1237	0
122	33,391°	123,391°	128,608°	0,275	0,571	0,725	92,105°	3,018	4,80E-02	0
122	193,131°	283,131°	297,294°	0,225	0,462	0,775	98,93°	2,029	1,31E-01	20
122	354,13°	84,13°	105,161°	0,47	1,063	0,53	70,411°	8,835	9,46E-05	20
122	100,59°	190,59°	215,239°	0,344	0,733	0,656	83,672°	4,741	8,00E-03	0
122	232,469°	322,469°	347,042°	0,106	0,214	0,894	121,294°	0,453	6,39E-01	0
122	271,225°	1,225°	21,615°	0,142	0,287	0,858	113,243°	0,804	4,50E-01	0
124	29,581°	119,581°	124,965°	0,623	1,608	0,377	55,703°	15,544	4,85E-08	0
124	248,088°	338,088°	352,401°	0,327	0,693	0,673	85,638°	4,284	1,30E-02	10
124	8,455°	98,455°	119,486°	0,095	0,19	0,905	124,448°	0,357	7,02E-01	20
124	165,233°	255,233°	279,882°	0,209	0,428	0,791	101,319°	1,754	1,74E-01	0
124	38,068°	128,068°	152,604°	0,351	0,749	0,649	82,937°	4,921	7,00E-03	0
124	306,735°	36,735°	57,018°	0,808	2,964	0,192	37,403°	26,121	1,54E-11	0
125	118,028°	208,028°	213,58°	0,431	0,956	0,569	74,29°	7,446	4,40E-04	0
125	104,668°	194,668°	208,981°	0,416	0,914	0,584	75,91°	6,914	7,86E-04	10
125	196,495°	286,495°	307,625°	0,33	0,7	0,67	85,271°	4,366	1,20E-02	20
125	74,624°	164,624°	189,305°	0,282	0,589	0,718	91,124°	3,188	4,00E-02	0
125	58,771°	148,771°	173,307°	0,287	0,599	0,713	90,572°	3,287	3,60E-02	0
125	163,151°	253,151°	273,325°	0,198	0,404	0,802	103,087°	1,571	2,09E-01	0
126	199,504°	289,504°	298,734°	0,835	3,368	0,165	34,402°	27,893	3,81E-12	0
126	233,351°	323,351°	340,642°	0,59	1,468	0,41	58,884°	13,911	2,79E-07	10
126	173,996°	263,996°	286,861°	0,088	0,177	0,912	126,264°	0,311	7,35E-01	20
126	188,732°	278,732°	303,782°	0,449	1,005	0,551	72,458°	8,082	2,19E-04	0
126	105,336°	195,336°	218,545°	0,21	0,429	0,79	101,297°	1,756	1,73E-01	0
126	241,508°	331,508°	349,424°	0,174	0,354	0,826	107,082°	1,216	2,98E-01	0
127	82,769°	172,769°	182,164°	0,276	0,574	0,724	91,953°	3,044	4,70E-02	0
127	113,979°	203,979°	221,402°	0,174	0,353	0,826	107,152°	1,211	3,00E-01	10
127	351,565°	81,565°	104,577°	0,228	0,468	0,772	98,516°	2,08	1,25E-01	10
127	4,396°	94,396°	119,457°	0,243	0,502	0,757	96,333°	2,368	9,30E-02	0
127	199,648°	289,648°	312,788°	0,218	0,446	0,782	100,027°	1,898	1,50E-01	0
127	74,885°	164,885°	182,672°	0,099	0,199	0,901	123,266°	0,391	6,79E-01	0
128	74,269°	164,269°	173,664°	0,236	0,486	0,764	97,329°	2,233	1,07E-01	0
128	41,298°	131,298°	148,721°	0,264	0,547	0,736	93,511°	2,788	6,10E-02	10
128	24,271°	114,271°	137,283°	0,393	0,854	0,607	78,329°	6,171	2,00E-03	10
128	195,416°	285,416°	310,477°	0,454	1,017	0,546	72,04°	8,232	1,85E-04	0
128	305,076°	35,076°	58,216°	0,596	1,494	0,404	58,262°	14,223	1,97E-07	0
128	39,412°	129,412°	147,069°	0,311	0,653	0,689	87,629°	3,857	2,00E-02	0
129	11,796°	101,796°	111,357°	0,384	0,832	0,616	79,255°	5,903	2,00E-03	0
129	149,65°	239,65°	257,335°	0,184	0,375	0,816	105,356°	1,36	2,58E-01	10
129	191,362°	281,362°	304,516°	0,225	0,463	0,775	98,911°	2,031	1,31E-01	10
129	234,832°	324,832°	349,897°	0,321	0,677	0,679	86,43°	4,11	1,60E-02	0

129	166,697°	256,697°	279,766°	0,356	0,761	0,644	82,366°	5,065	6,00E-03	0
129	204,342°	294,342°	311,868°	0,15	0,304	0,85	111,58°	0,902	4,08E-01	0
130	152,827°	242,827°	252,388°	0,495	1,137	0,505	67,907°	9,818	3,12E-05	0
130	86,228°	176,228°	193,913°	0,086	0,172	0,914	126,977°	0,294	7,47E-01	10
130	45,61°	135,61°	158,833°	0,316	0,667	0,684	86,925°	4,004	1,70E-02	10
130	357,04°	87,04°	112,107°	0,397	0,865	0,603	77,856°	6,312	2,00E-03	0
130	322,067°	52,067°	75,136°	0,108	0,216	0,892	120,996°	0,463	6,32E-01	5
130	89,149°	179,149°	196,543°	0,684	1,911	0,316	49,937°	18,714	3,42E-09	0
131	47,472°	137,472°	147,197°	0,189	0,385	0,811	104,602°	1,427	2,41E-01	0
131	49,796°	139,796°	157,611°	0,698	1,993	0,302	48,602°	19,479	1,99E-09	10
131	33,453°	123,453°	146,744°	0,073	0,147	0,927	131,034°	0,214	8,09E-01	10
131	68,514°	158,514°	183,583°	0,171	0,348	0,829	107,622°	1,174	3,11E-01	0
131	63,8°	153,8°	176,724°	0,253	0,523	0,747	94,97°	2,564	7,60E-02	5
131	15,156°	105,156°	122,417°	0,308	0,647	0,692	87,981°	3,785	2,20E-02	0