2019 abundance of orange roughy in ORH7B Cook Canyon

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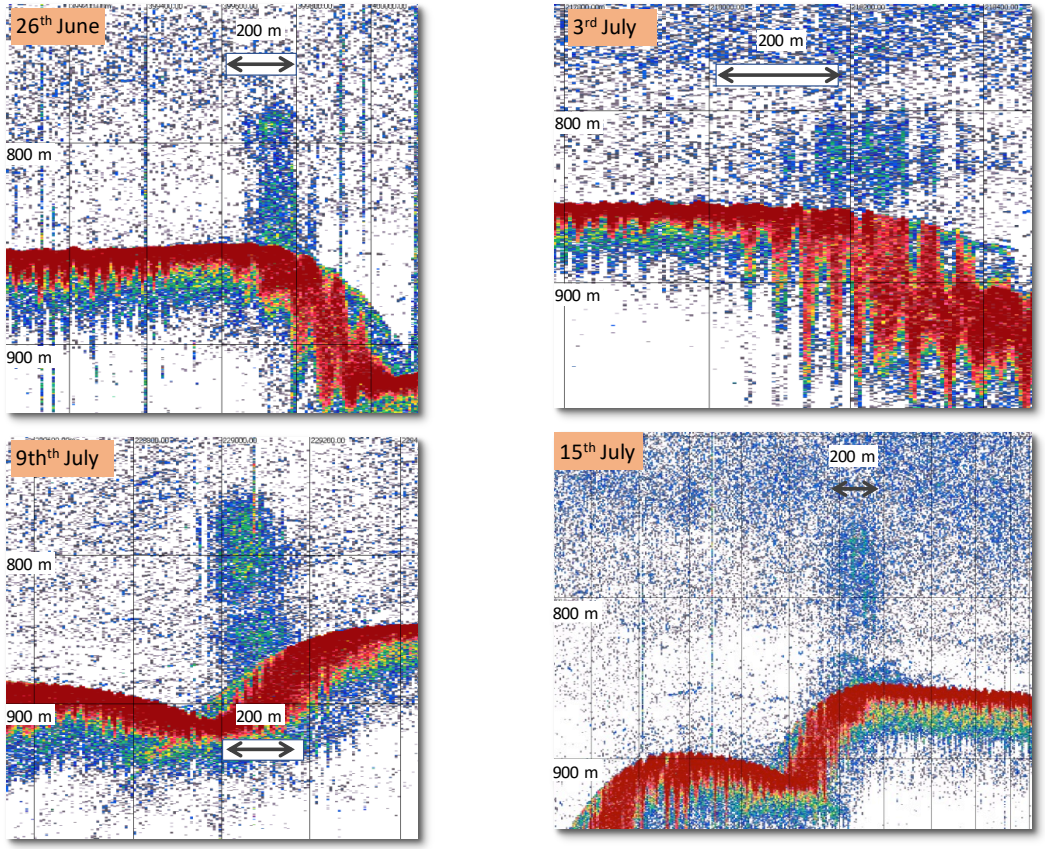


1. CSIRO Oceans and Atmosphere Flagship
2. Thalassa

Objectives

Specific Project Objective

To estimate the spawning biomass of orange roughy in ORH7B during June-July 2019 for use in a revised stock assessment to inform the management of this stock.

Voyage Objectives

1. To search for orange roughy spawning aggregations in and around the Cook Canyon area.
2. To estimate the spawning abundance of orange roughy in the area with a target coefficient of variation (c.v.) of the estimate of 20 - 30% using an acoustic survey.
3. To collect biological material to inform the acoustic data.

Survey design

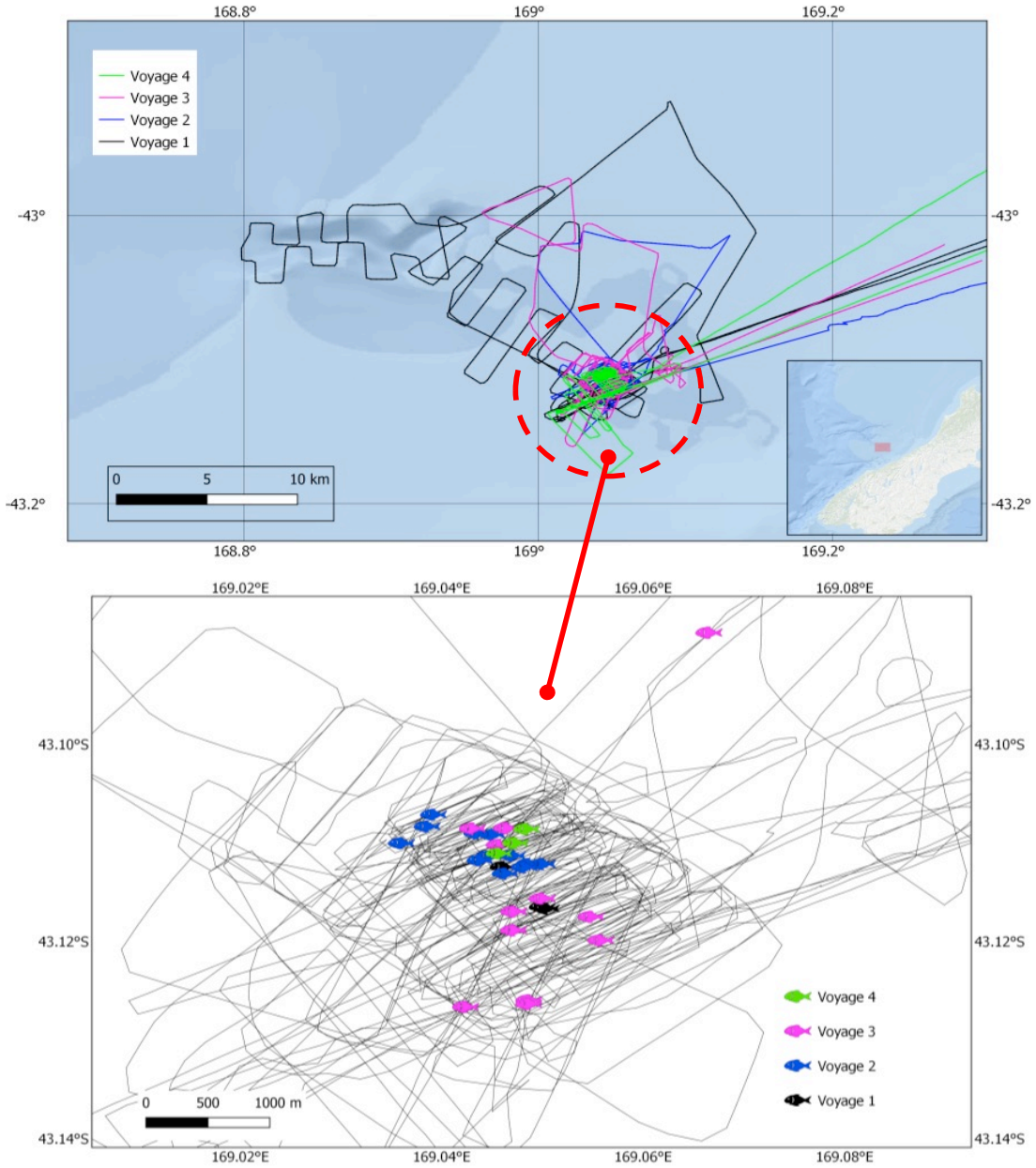
Amaltal Mariner carried out four six-day voyages to fish hoki in late June to mid-July

Each voyage had a 24 hour charter period that was initiated when conditions were at their calmest

During charter period vessel conducted acoustic transect surveys using calibrated vessel-mounted echosounder and demersal trawling of Cook Canyon ORH.

Some limited searching but focus on main spawning location as identified in 2015, 2016 and 2017 surveys.

Demersal tows for species id and biologicals (length, weight, sex, stage and otoliths (700). 50 t allocated.



Vessel tracks from four 24 hour survey periods (upper panel). Lower panel shows tracks of main survey box. Fish markers indicate location of acoustically observed ORH schools

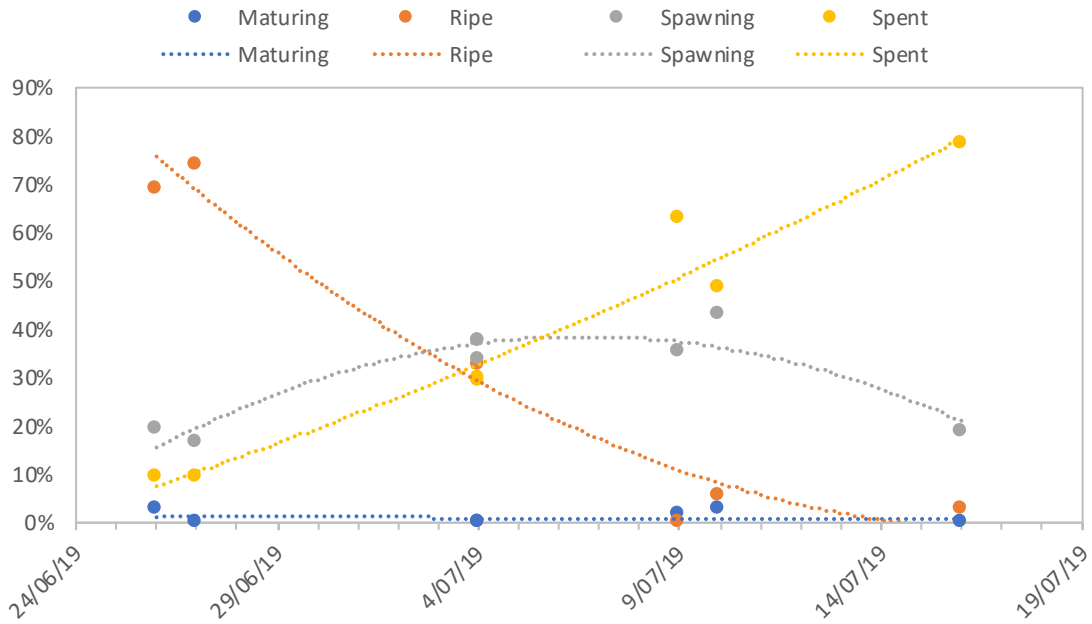
Biomass estimation

- Calibrated 38 kHz vessel acoustics conduct interlaced transect surveys
- Extra transects on outer edge to ‘bound’ aggregation
- Mean ORH backscatter based on average value echointegrated regions from all transects treated as single entity
- Biomass estimates multiplied by DWWG 1.3 correction factor to account for signal loss due to motion and bubble layer attenuation

Results – biologicals – spawning progression

Female spawning condition

- 26th June – 20% spawning , 10% spent
- 4th July – 30% spawning, 35% spent/partially spent
- 9-10th July – 39% spawning, 55% spent/partially spent
- 16th July – 19% spawning, 78% spent



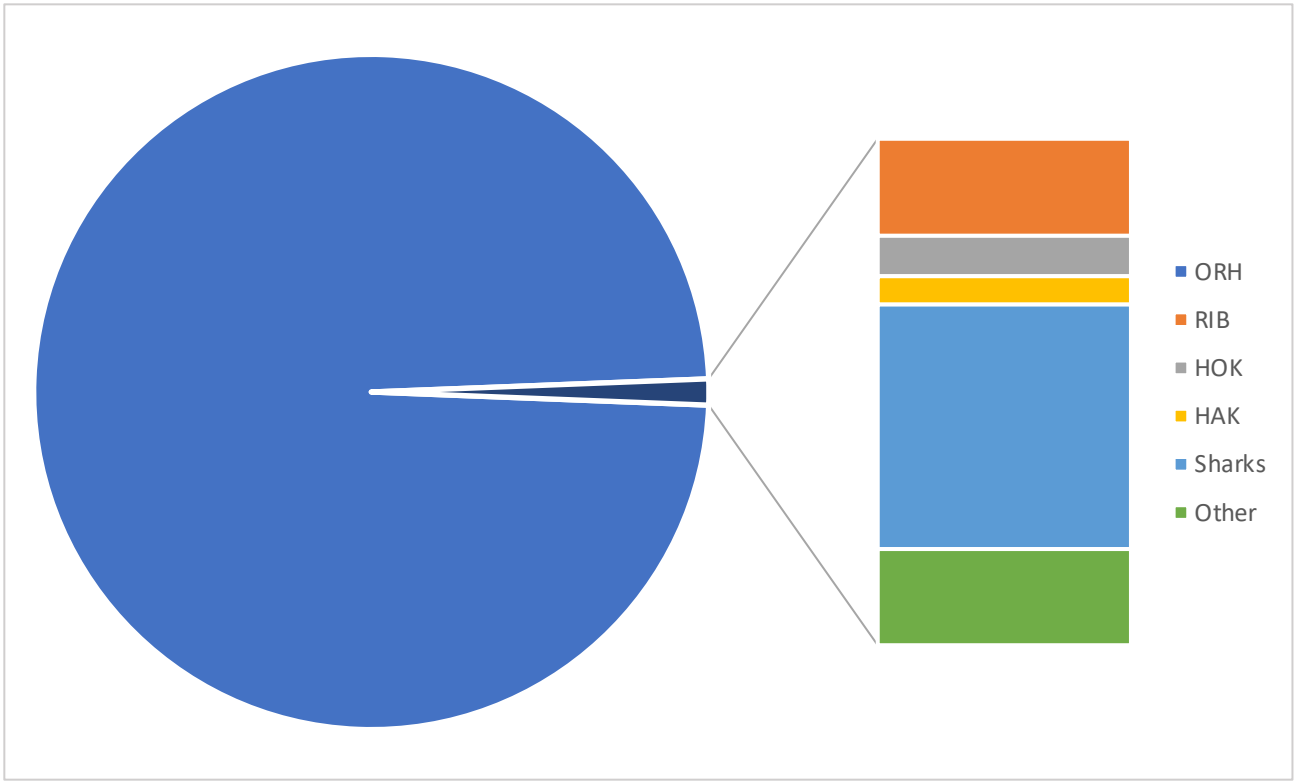
Survey period effectively captured spawning event

Results – biologicals – catch composition

7 trawls on main aggregation
ORH between 94.7% and 99.6% (average 98.8% by weight)

Allocated catch: 50 tonnes
Catches between 2.5 and 18 tonnes
Total catch 57.7 tonnes.

Top bycatch
Deep water sharks (leafscaled gulper shark, Plunket's shark, smoothskin dogshark and seal shark), ribaldo, hoki and hake

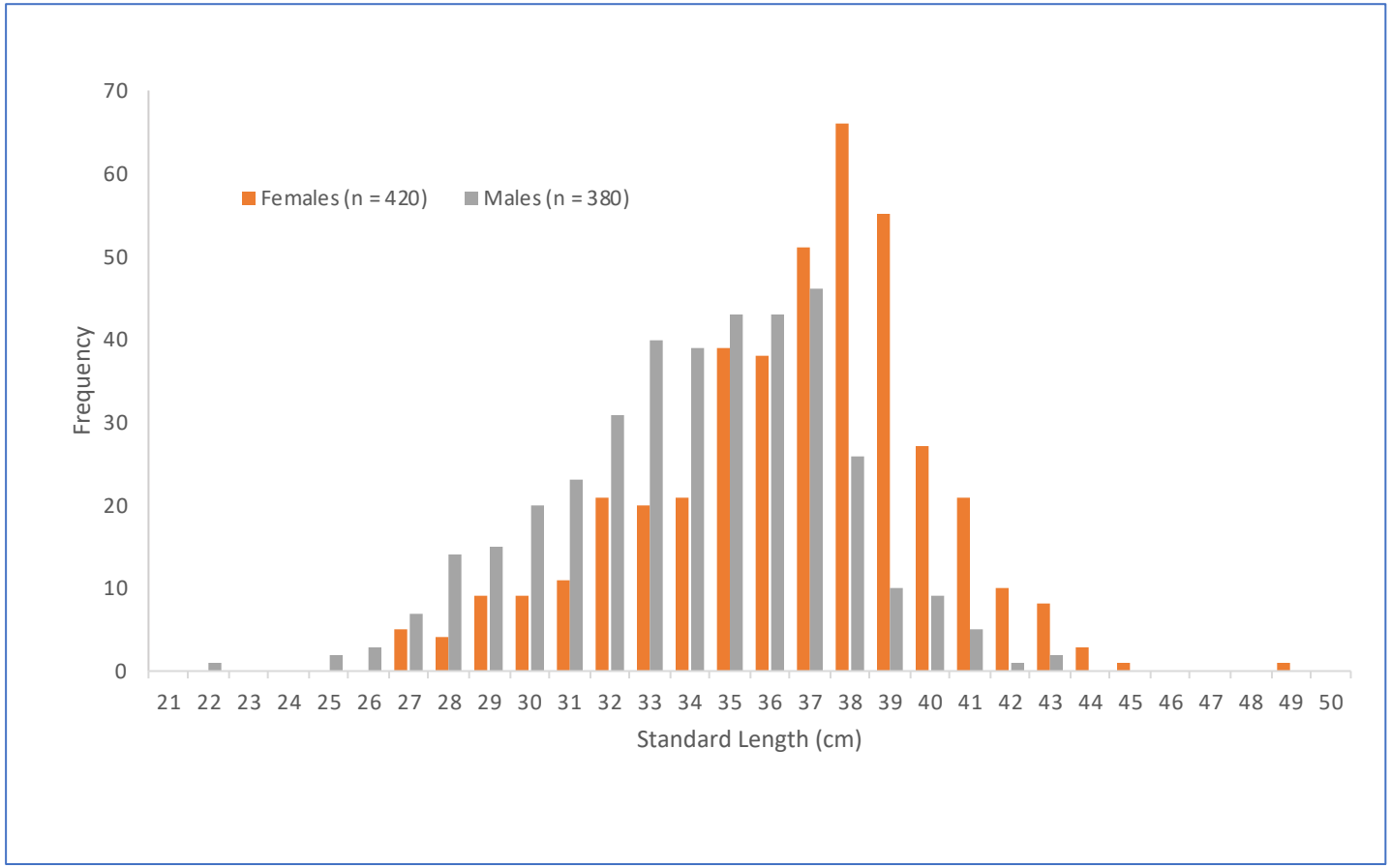


Results – biologicals – size, weight and sex ratio

	Female	Male
No. LF measures	420	380
Weight (g)	1601	1236
Standard Length (cm)	36.6	34.1
Catch ratio (%)	52.5	47.5
No. otolith samples	700	

Increase in mean size 2015 - 2019

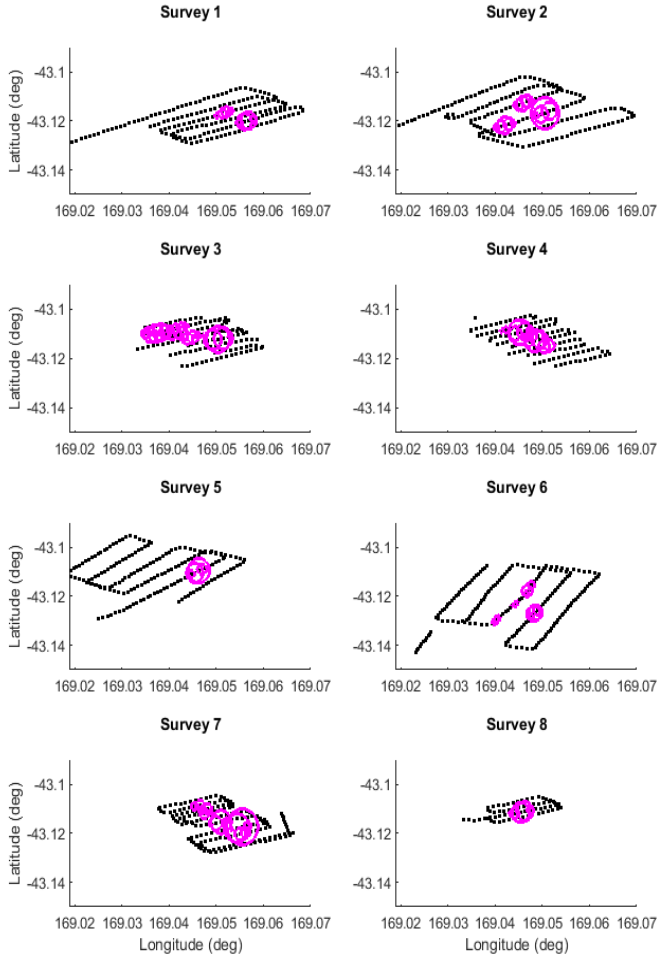
Survey Year	Female (cm)	Male (cm)
2019	36.6	34.1
2017	34.9	31.9
2015	32.4	31.0



Results

8 acoustic surveys.

- 7 in calm conditions, one conducted running with weather
- Between 4 and 10 transects and 30 to 128 minutes duration
- Single ‘main’ aggregation observed at roughly the same location as 2015, 2016 and 2017 surveys (found within an area of ~ 2 nautical miles)
- Aggregation had degree of dynamic behaviour, building up and declining within 24 hour period. Densities generally higher after dusk and before dawn
- Survey design did not allow sustained observation of aggregation or extensive searching of wider area (but previous surveys did and did not find significant ORH aggregations)



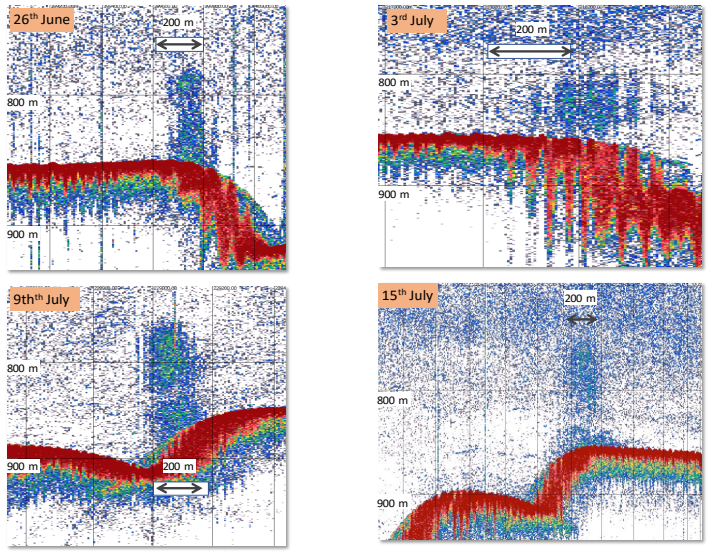
Snapshot No.	Date	No. Transects	Avg. Vessel Speed (knots)	Snapshot Duration (minutes)
1	26/06/19	6	9.1	59
2	26/06/19	6	9.0	67
3	03/07/19	9	5.8	128
4	04/07/19	9	6.6	121
5	09/07/19	6	7.2	67
6	09/07/19	5	8.3	76
7	10/07/19	10	7.6	75
8	16/07/19	4	7.1	30

Results – echogram interpretation

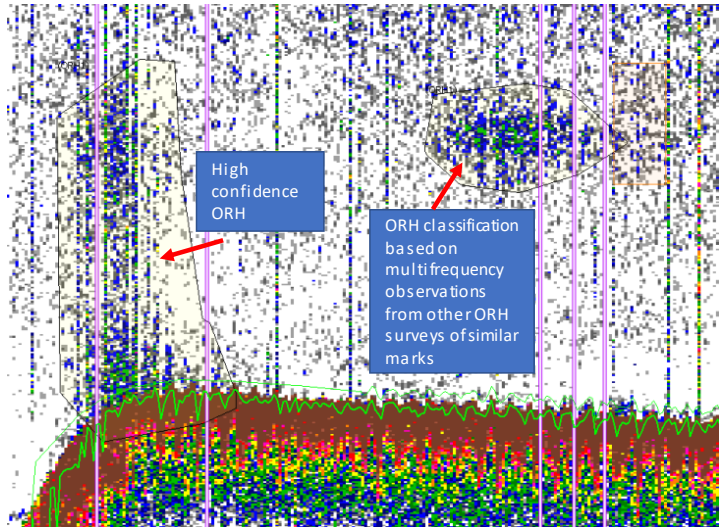
38 kHz vessel acoustics for 2019 survey used a range of evidence to support interpretation

- Main aggregation at same location as observed in 2015 (multifrequency AOS acoustics + trawl), 2016 (NIWA trawl survey and 2017 (multifrequency AOS acoustics + trawl)
- 2019 targeted trawl shots
- Shape, location and behaviour of aggregation

Echogram edited to classify all significant marks as ORH



ORH schools for voyages 1-4



Example of interpretation of ORH schools

Acoustic biomass estimates

Survey No	Date	Survey Area ($n.mi^2$)	No transects	Mean NASC ($m^2/ni.m^2$)	**Total biomass (tonnes)**	CV	Survey A	Survey B	Combined (mean A and B)	Combined (geometric mean)
1	26-Jun	1.051	6	12	**318 (9.6%)**	0.48	299	613	456	428
2	26-Jun	1.54	6	36.7	**1393* (7.4%)**	0.35	2294	552	1423	1125
3	3-Jul	0.489	9	80.8	**927 (2.6%)**	0.21	851	887	869	868
4	4-Jul	0.437	9	69.5	**746 (7%)**	0.31	1289	257	773	575
5	9-Jul	1.249	6	17.6	**511 (1.8%)**	0.64	0	1084	542	0
6	9-Jul	1.78	5	11.5	**473 (0.8%)**	0.38	388	591	489	479
7	10-Jul	0.421	10	95.1	**958 (4.4%)**	0.33	616	1200	908	859
8	16-Jul	0.179	4	45.3	**198 (6%)**	0.58	0	516	258	0

* This estimate reduced to ~ 970 tonnes if a 'midwater' aggregation is excluded

- Transects on outer edges of survey box to 'bound' the aggregations
- Surveys followed 'interlaced' pattern to minimize potential effects of fish movement
- Very rapid exercise – 30 to 128 minutes with low number of transects (aggregation covering small area)
- Interlaced surveys can be treated as two independent surveys (A & B) and combined via geometric mean
- This leads to higher survey CV's due to lower spatial sampling intensity. On some surveys the small aggregation was not encountered or very low on the A or B run
    - The geometric mean tends to zero as surveys A and B diverge. In two cases geometric mean was zero!
- Given – small size of aggregation, the very fast speed of completing surveys and low sampling intensity if splitting into A and B surveys recommend that each survey is treated as a single entity (results in the orange column).

Acoustic biomass estimates

Survey No	Snapshot Start Time	Date	Survey Area ($n.mi^2$)	No transects	Mean NASC ($m^2/ni.m^2$)	Total biomass (tonnes)	CV	Survey A	Survey B	Combined (mean A and B)	Combined (geometric mean)
1	13:30	26-Jun	1.051	6	12	318 (9.6%)	0.48	299	613	456	428
2	22:00	26-Jun	1.54	6	36.7	1393* (7.4%)	0.35	2294	552	1423	1125
3	23:32	3-Jul	0.489	9	80.8	927 (2.6%)	0.21	851	887	869	868
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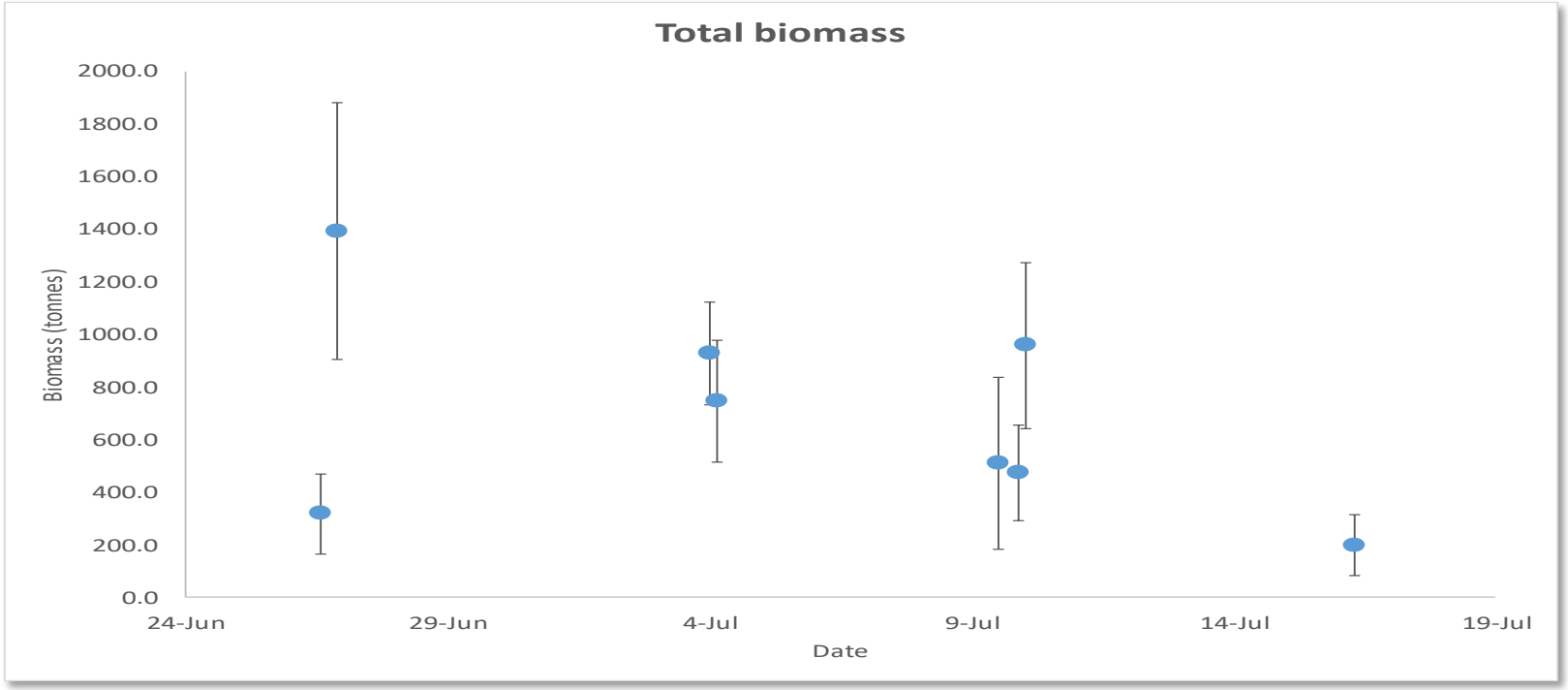
7	00:43	10-Jul	0.421	10	95.1	958 (4.4%)	0.33	616	1200	908	859
8	07:31	16-Jul	0.179	4	45.3	198 (6%)	0.58	0	516	258	0



Discussion points

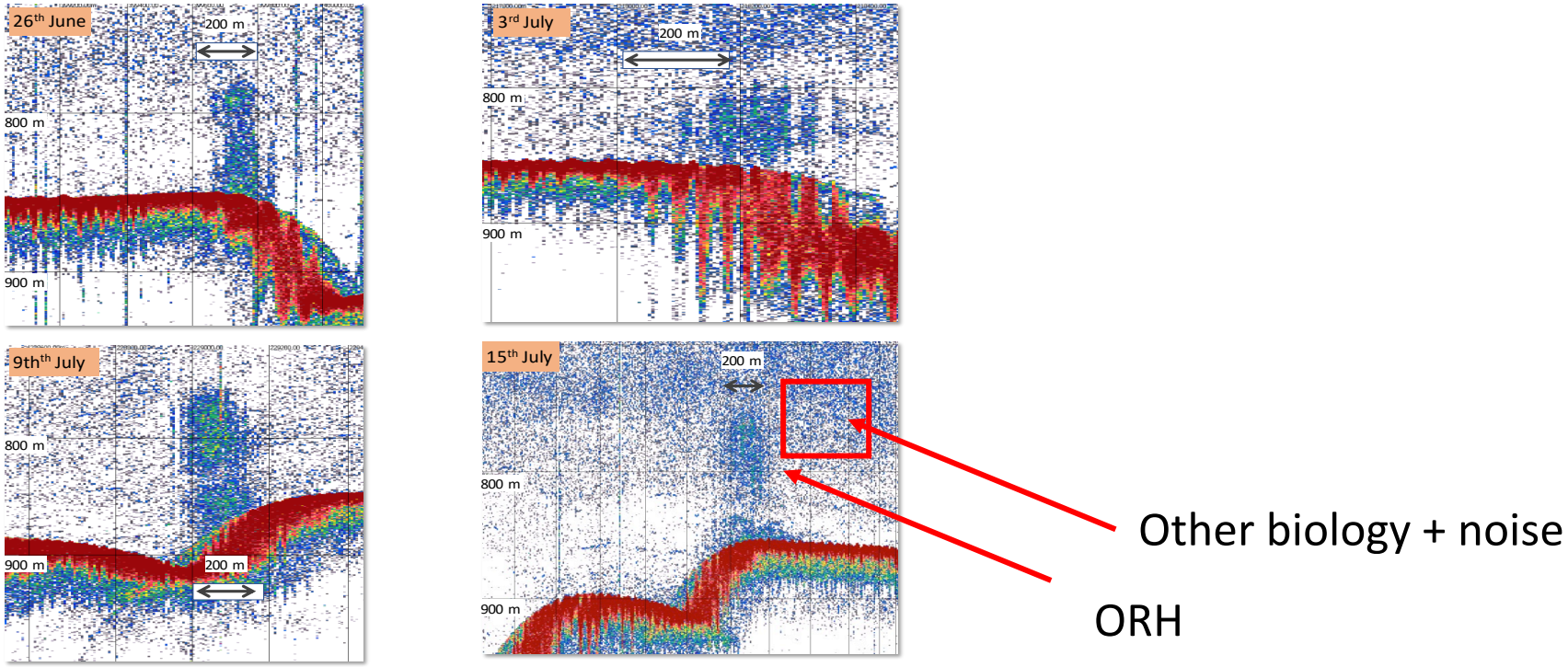
- Cook Canyon has single ‘main’ aggregation found at essentially same location in 2015, 2016, 2017 and 2019.
- Extending surveys over 20 day period ensured coverage of peak-of-spawn
- Aggregation has ‘classic’ ORH form but much lower density than other locations (cf ~1 fish per 100 m^3 to 5-50 fish per 100 m^3 for ORH7A Challenger Plateau aggregation)
- Biomass estimates ranged from 196 to 1393 tonnes (cf 627 to 930 tonnes, n =3 in 2017 using Acoustic Optical System (multifrequency, deeply deployed)
- High degree of variability – e.g. survey 1 = 318 tonnes, survey 2 1393 tonnes within 24 hour period. Dynamics of the aggregations determines ‘availability to the acoustics’.

Discussion points - uncertainty

- Species identification good confidence given historic knowledge with confirmation from trawling and multifrequency acoustics
- Cook Canyon at the margins for vessel acoustics due to low density ORH and deeper depths (800-1000 m). [other locations e.g. Rekohu 600-700 m and factor of 5 to 50 higher ORH densities]
- ORH backscatter just above that of background biology and noise

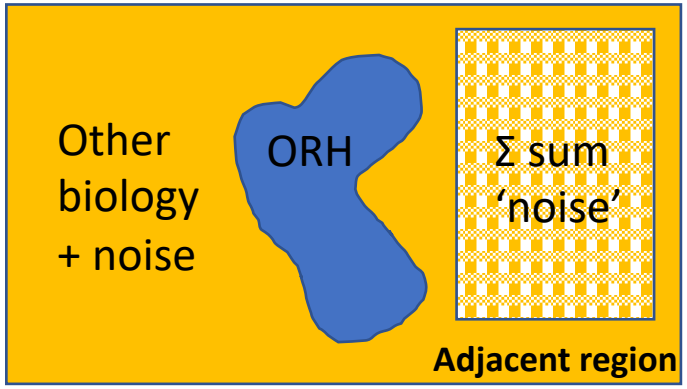
Discussion points – low signal to noise environment

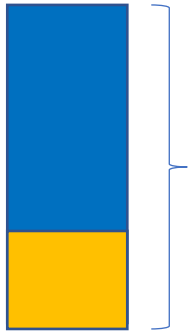
What might be the potential contribution (i.e. positive bias) from other biology and noise within defined ORH regions?



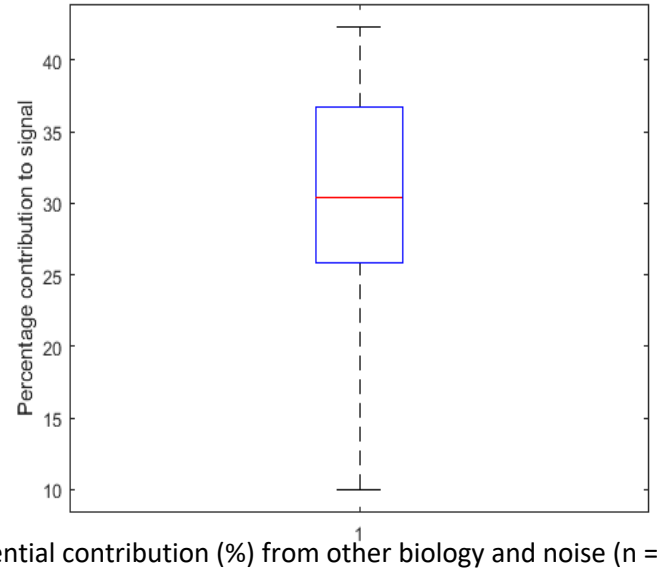
Discussion points – low signal to noise environment

Check – assume biology & noise in surrounding area is same as within ORH region
22 regions adjacent to ORH regions analysed.
~30% of signal <u>within</u> ORH regions could be due to other biology & noise (i.e. positive bias)





Total backscatter = ORH contribution + other biology & noise



Potential contribution (%) from other biology and noise (n = 22)

Perhaps a worse case: Ryan and Kloser (2016) noted 'empty' water regions following ORH avoidance suggesting non-roughy species within ORH schools may have lower densities than surrounding regions

Uncertainty estimates

Parameter	Amount (%)	Comment
Absorption estimate	30	Doonan absorption equation was used. The alternate Francois and Garrison absorption estimate would increase biomass by 30% for Cook Canyon orange roughy depths of ~ 870 m. More research recommended to directly measure absorption at both 38 kHz and 120 kHz.
DWWG Correction factor	-30	This correction factor combines motion and attenuation due to presumed bubble attenuation effects. An alternative is to directly correct for motion effects and then consider bubble attenuation effects as a single correction factor. Recommendation for more research to understand bubble attenuation effects across a range of vessels and situations.
Motion effects	For this study biomass from uncorrected data were between 2-30% less. When corrected expect residual error of only a few percent.	Directly correct for motion effects by measuring at Nyquist sampling frequency.
'Noise' contribution	Up to +30%	Contribution to signal by noise and co-occuring species could be as much as 30% for these regions of low acoustic backscatter. Uncertainty can be reduced through use of deeply deployed multifrequency platforms.

Conclusion

- Vessel-acoustics survey program was able to locate, identify and survey ORH
- Results broadly comparable to 2017 survey
- Small body of fish, low density aggregation observed somewhere within ~ 2 nm area over multiple years
- Careful monitoring needed if planning to fish commercially
- Survey program of brief excursions from commercial fishing operation proved to be a successful method of conducting cost-effective monitoring of the Cook-Canyon aggregation.