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Coverage of the 2022 Canadian (Newfoundland And Labrador Region) Multi-Species RV Bottom Trawl Survey with notes on Comparative Fishing

by

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Abstract

We document the spatial coverage of the 2022 spring multispecies bottom trawl survey conducted by the Department of Fisheries and Oceans, Newfoundland and Labrador Region. The 2022 spring RV survey was undertaken with the new research vessel CCGS *John Cabot*. The survey covered Div. 3NOPs at reduced allocations, and a portion of Div. 3L. This marks three years in a row where Divs. 3LNO were incomplete. Comparative fishing has not been completed, so data from this survey are not yet comparable to the previous series, and indices are not presented here. The fall 2022 bottom trawl survey did not occur. Instead, the fall program focused on targeted comparative fishing to help with the transition to new Research Vessels for the Canadian surveys. Survey coverage issues continue to add an unquantified level of uncertainty to groundfish and invertebrate assessments. Analysis of Comparative fishing is ongoing, however incomplete comparative fishing with the CCGS Alfred Needler, particularly on the Grand Bank, will hinder the integrity of the existing time series, leading to potentially serious problems for ecosystem and stock assessments going forward.

Introduction

The Canadian Department of Fisheries and Oceans (DFO), Newfoundland and Labrador Region, has undertaken stratified-random surveys in portions of NAFO subareas 2+3 since the early 1970's. A full description of the history of these surveys, including stratification, trawl gear, towing protocols, vessels employed, as well as details of spatial coverage have been detailed in previous documents (e.g. Brodie, 2005, Brodie and Stansbury, 2007, Healey and Brodie, 2009, Healey et al., 2012, and references therein). The current document diverges from the document typically produced annually for the June meeting of NAFO Scientific Council (see Rideout et al., 2022 for the most recent version), providing limited information from the uncalibrated 2022 spring survey and ongoing comparative fishing program.

Methods

The Canadian (NL Region) research vessel (RV) multispecies bottom trawl surveys cover Divisions 2HJ3KLNO (515,000 km²) in the autumn and Divisions 3LNOP (324,000 km²) in the spring. The survey area is stratified by depth range. Survey sets (i.e. standardized fishing hauls at a randomly selected sampling unit) for these stratified-random surveys are distributed using a proportional-allocation scheme, whereby the number of



sets allocated for a given stratum is proportional to the stratum area, subject to the condition that each stratum must be allocated a minimum of two sets. Tow sites are randomly selected from sampling units within each stratum, with each sampling unit typically encompassing an area of approximately 3.5 square nautical miles (Doubleday, 1981). Within each stratum, one alternate station is also selected, and is occupied if a sample from one of the other units cannot be obtained (e.g. untrawable bottom). A constraint is applied to the random sampling to permit selection of only one sampling unit within each consecutive group of 10 units (i.e maximum of one unit selected from units 1-10, 11-20, 21-30, etc.).

When computing the stratified estimators of abundance or biomass for any given species, individual strata must have a minimum of two successful survey sets to be considered completed to enable calculation of stratum variance. Strata down to 1500 m are included in the survey design for the autumn survey, whereas the spring survey does not cover strata deeper than 732 m.

The vessels employed during autumn surveys are currently transitioning from the CCGS *Alfred Needler* and the CCGS *Teleost* to the CCGS *Capt. Jacques Cartier* and CCGS *John Cabot*. During spring surveys, typically only the CCGS *Alfred Needler* is used; the CCGS *Teleost* has been deployed at times when the CCGS *Alfred Needler* was unavailable due to significant mechanical problems. The spring survey is also transitioning from the old vessels, and in 2022 was undertaken with the CCGS *John Cabot*. The current sampling gear used for the RV surveys is the Campelen 1800 shrimp trawl. This trawl was first deployed in the 1995 autumn survey, and has been used in all spring surveys since 1996. McCallum and Walsh (1996) provide a detailed description of the Campelen 1800 trawl. Minor modifications have been made to the Campelen 1800 trawl for use with the *Cabot* and *Cartier* now and going forward:

- Shortened Belly #2 and Side panel #5 (from 255.5 to 199.5 meshes deep) to minimize net damage.
- Redesigned lower bottom Belly #1 (where the damage frequently occurs) into 3 sections.
- Added a tear-stop rope between bottom Belly #1 and bottom Belly #2 to prevent further damage/tear-up to the other bottom panels further aft (Bellies #2 and 3, codend extension).
- Lengthened Side panels # 2 and corresponding Top Bunt Wing panels (from 41.5 to 48.5 meshes) to reduce any netting slack, a potential area for damage.
- Replaced the traditional rockhopper footgear disks (known as curved disks which are cut out from tires, that varied in shapes and weights) with a newer type of disks which are standardized in shape and weight and these are more readily available in the fishing gear supply market.

Spring Survey 2022

The spring survey encompasses Divs. 3LNOPs (Fig. 1-4), and is conducted from early-April through to late June. The spring survey typically utilizes a single vessel, since 2009 the CCGS *Alfred Needler*, but mechanical issues with this vessel in some years have required the use of the CCGS *Teleost* to complete the survey. Starting in 2022, the CCGS *John Cabot* is the primary research vessel for the Spring survey.

New Research Vessels: Update on Comparative Fishing

The Department has introduced two new offshore fisheries research vessels in the Atlantic regions to eventually replace the current research vessels: the CCGS *Captain Jacques Cartier* (hereafter referred to as *Cartier*) to replace the CCGS *Alfred Needler*, and the CCGS *John Cabot* (hereafter referred to as *Cabot*) to replace the CCGS *Teleost*. The *Cartier* and *Cabot* arrived in the spring and autumn of 2020, respectively. Mechanical, technical, and COVID-19-related issues delayed their transition into service. In order to maintain a comparable time series, comparative fishing is required to determine relative differences in catchability between the vessels and survey gears. The Newfoundland and Labrador region is maintaining the existing survey trawl (Campelen 1800 survey trawl), with a few modifications aimed at minimizing trawl damage during fishing (see above), and switching to standardized commercial rock hopper footgear discs.

The comparative fishing program was designed as a “shadow survey” (Thiess et al. 2018), whereby both vessels fish side by side across the standard survey design to maximize the likelihood that conversion factors are applicable over the range of conditions and species where they will be applied for both single-species and ecosystem assessments. However, this approach was unsuccessful in the Fall of 2021 and Spring of 2022 with limited sampling achieved (Table 1).

Fall 2021

In the fall of 2021 a shadow survey at a 70% allocation of the standard multispecies survey was planned for comparative fishing between the *Teleost* and *Cartier*, and the *Needler* and *Cabot*. However, vessel availability was limited and this program was not completed. Paired tows were only completed on portions of three trips between the *Teleost* and the *Cartier*, with paired sampling occurring in NAFO Divs. 2HJ3K. Fall survey coverage is detailed in Rideout et al. 2022.

Spring 2022

In the spring of 2022 a shadow survey at a 70% allocation was planned for comparative fishing between the *Needler* and *Cabot*. However, vessel availability was limited and this program was not completed. Paired tows were only completed on portions of three trips, with pairs in Subdiv. 3Ps and Div. 3N.

A decision was made for the Fall of 2022 to switch to a targeted approach to comparative fishing to increase efficiency, target high priority species and areas and maximize the likelihood that useful conversion factors can be derived for at least some aspects of the survey data. This shift meant abandoning the typical survey plan, therefore there was no fall 2022 Multispecies Survey.

Fall 2022

The targeted approach to comparative fishing prioritized a few key species/stocks, and occurred over a restricted spatial scale rather than the entire survey area. Target areas were determined by examining the distribution (occurrence and density) of the four priority target species (Atlantic cod, Greenland halibut, Northern shrimp, Snow Crab), along with relative density of fish functional groups, species diversity and species richness. Planned sampling areas were defined in each of the three Ecosystem Production Units (EPUs) encompassed by the fall survey area, with sets allocated in all 6 NAFO Divisions, and across the standard depth range of the survey and at locations of various bottom topography – broadly defined for comparative fishing considerations as bank, slope, and channels. Sampling across the typical conditions encountered in the survey allowed for the best chance at obtaining unbiased conversion factors for high priority stocks, and collection of data that are broadly applicable across species and areas. Sets were allocated within the standard survey strata, at or above the typical survey fishing density. While the selection of areas considered a few key species, all species caught during comparative fishing trials were identified, weighed, and measured in an effort to convert as broad a range of data as possible.

Results & Discussion

Substantive mechanical issues with the research vessels in recent years have made completion of the recent multispecies bottom trawl surveys and comparative fishing program very difficult.

Spring 2022

Due to limitations in vessel availability and efficiency, and planned comparative fishing, the survey in 2022 was not fully completed. Div. 3L was incomplete, with a portion of strata sampled with 2 sets per strata (Fig. 5). Div. 3NO were surveyed at 2 sets per strata, the minimum required to enable calculation of strata variance (Fig. 5-7). Subdivision 3Ps was completed at a roughly 80% allocation (Fig. 8).

Impacts of the reduced allocation in Div. 3LNO on the estimation of species biomass, abundance, and uncertainty around these estimates should be critically assessed prior to any indices being used for

assessments. Since the survey design allocates sets proportional to stratum area, set reductions to 2 per strata disproportionately impact larger strata whereas smaller strata (slope strata) that are normally allocated 2 sets are not impacted.

Tables 2-5 provide the number of successful survey sets by stratum in Div. 3LNOPs. Figures 10 through 17 present the distribution of catches of select species in the Spring 2022 survey. These catches are from the *CCGS J. Cabot* and are unconverted. Data should not be directly compared to results from previous spring surveys.

Fall 2022

Not all planned target areas were reached (Fig. 9). The *CCGS Teleost* program was largely completed, while the *Needler* was out of service for a large portion of the season and coverage was limited. Notably, no paired tows were completed by the *CCGS A. Needler* on the Grand Bank (Div. 3LNO) in strata >183m.

Limitations on the winches on the *CCGS J. Cabot* and *CCGS Capt. J. Cartier* precluded fishing below 1000m in the Fall of 2022.

The *CCGS A. Needler* was retired in February 2023. This retirement occurred before its comparative fishing program could be achieved. Analyses are ongoing, but it is expected that there will be widespread and significant gaps in our ability to convert the *Needler* survey time series.

The comparative fishing program is ongoing.

Acknowledgements

The Canadian multispecies survey dataset would not exist without extensive efforts on the part of the Fisheries and Oceans Canada scientific sampling teams as well as the crews of the *CCGS Teleost*, *CCGS A. Needler*, *CCGS J. Cabot*, and *CCGS Capt. J. Cartier*.

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Table 1. Summary of successful paired sets per vessel pair, year and season, where AN represents the CCGS *Alfred Needler*, CAB represents the CCGS *John Cabot*, CAR represents the CCGS *Jacques Cartier*, and TEL represents the CCGS *Teleost*.

Vessel Pair	Year	Season	NAFO Div.	# Successful Paired Tows
TEL:CAR	2021	Fall	2H	14
			2J	18
			3K	8
			Total	40
AN:CAB	2022	Spring	3N	12
			3P	25
			Total	37
AN:CAB	2022	Fall	3K	71
			3L	2
			3N	17
			3O	10
			Total	100
TEL:CAR	2022	Fall	2H	20
			2J	38
			3K	82
			Total	140
TEL:CAB	2022	Fall	2J	5
			3K	8
			3L	4
			Total	17

Table 2. Summary of successful survey sets by the CCGS *John Cabot* in the Spring of 2023 in Division 3L.

Stratum	Min. depth (m)	Max. Depth (m)	# sets in full allocation	# sets completed	Proportion of full allocation completed
328	93	183	5	0	0.00
341	93	183	5	0	0.00
342	93	183	2	0	0.00
343	93	183	2	0	0.00
344	184	274	5	0	0.00
345	275	366	5	0	0.00
346	275	366	3	0	0.00
347	184	274	3	0	0.00
348	93	183	7	1	0.14
349	93	183	7	0	0.00
350	57	92	7	1	0.14
363	57	92	6	2	0.33
364	93	183	9	1	0.11
365	93	183	3	0	0.00
366	184	274	5	0	0.00
368	275	366	2	2	1.00
369	184	274	3	0	0.00
370	93	183	4	0	0.00
371	57	92	4	1	0.25
372	57	92	8	2	0.25
384	57	92	4	2	0.50
385	93	183	8	2	0.25
386	184	274	3	0	0.00
387	275	366	2	2	1.00
388	275	366	2	2	1.00
389	184	274	3	2	0.67
390	93	183	5	2	0.40
391	184	274	2	2	1.00
392	275	366	2	2	1.00
729	367	549	2	0	0.00
730	550	731	2	0	0.00
731	367	549	2	2	1.00
732	550	731	2	2	1.00
733	367	549	2	2	1.00
734	550	731	2	1	0.50
735	367	549	2	2	1.00
736	550	731	2	2	1.00
		TOTAL	142	37	0.26

Table 3. Summary of successful survey sets by the CCGS *John Cabot* in the Spring of 2023 in Division 3N.

Stratum	Min. depth (m)	Max. Depth (m)	# sets in full allocation	# sets completed	Proportion of full allocation completed
357	275	366	2	2	1.00
358	184	274	2	2	1.00
359	93	183	2	3	1.50
360	57	92	10	2	0.20
361	57	92	6	2	0.33
362	57	92	9	2	0.22
373	57	92	9	2	0.22
374	57	92	3	2	0.67
375	1	56	5	2	0.40
376	1	56	5	3	0.60
377	93	183	2	2	1.00
378	184	274	2	2	1.00
379	275	366	2	0	0.00
380	275	366	2	2	1.00
381	184	274	2	3	1.50
382	93	183	2	2	1.00
383	57	92	2	2	1.00
723	367	549	2	2	1.00
724	550	731	2	2	1.00
725	367	549	2	0	0.00
726	550	731	2	0	0.00
727	367	549	2	2	1.00
728	550	731	2	3	1.50
		TOTAL	79	44	0.56

Table 4. Summary of successful survey sets by the CCGS *John Cabot* in the Spring of 2023 in Division 30.

Stratum	Min. depth (m)	Max. Depth (m)	# sets in full allocation	# sets completed	Proportion of full allocation completed
329	93	183	5	2	0.40
330	57	92	7	4	0.57
331	57	92	2	2	1.00
332	93	183	3	3	1.00
333	184	274	2	2	1.00
334	275	366	2	2	1.00
335	275	366	2	0	0.00
336	184	274	2	2	1.00
337	93	183	3	2	0.67
338	57	92	6	2	0.33
339	93	183	2	2	1.00
340	57	92	5	2	0.40
351	57	92	8	3	0.38
352	57	92	8	2	0.25
353	57	92	4	2	0.50
354	93	183	2	2	1.00
355	184	274	2	2	1.00
356	275	366	2	2	1.00
717	367	549	2	2	1.00
718	550	731	2	2	1.00
719	367	549	2	1	0.50
720	550	731	2	1	0.50
721	367	549	2	2	1.00
722	550	731	2	2	1.00
		TOTAL	79	48	0.61

Table 5. Summary of successful survey sets by the CCGS *John Cabot* in the Spring of 2023 in Subdivision 3Ps.

Stratum	Min. depth (m)	Max. Depth (m)	# sets in full allocation	# sets completed	Proportion of full allocation completed
293	57	92	2	2	1.00
294	93	183	2	2	1.00
295	184	274	2	2	1.00
296	275	366	2	2	1.00
297	93	183	2	2	1.00
298	184	274	2	2	1.00
299	275	366	2	2	1.00
300	184	274	2	2	1.00
306	184	274	3	2	0.67
307	93	183	3	2	0.67
308	57	92	2	2	1.00
309	184	274	2	2	1.00
310	184	274	2	2	1.00
311	93	183	3	2	0.67
312	57	92	2	2	1.00
313	184	274	2	2	1.00
314	1	56	8	4	0.50
315	57	92	7	7	1.00
316	184	274	2	2	1.00
317	93	183	2	2	1.00
318	184	274	2	2	1.00
319	93	183	8	8	1.00
320	1	56	11	11	1.00
321	57	92	10	10	1.00
322	93	183	13	9	0.69
323	93	183	6	5	0.83
324	93	183	4	2	0.50
325	57	92	8	8	1.00
326	57	92	2	2	1.00
705	275	366	2	2	1.00
706	275	366	4	2	0.50
707	275	366	2	2	1.00
708	367	549	2	2	1.00
709	550	731	2	2	1.00
711	367	549	5	3	0.60
712	367	549	6	4	0.67
713	367	549	7	5	0.71
714	367	549	9	5	0.56
715	275	366	2	2	1.00
716	275	366	4	2	0.50
779	184	274	4	3	0.75
780	184	274	3	2	0.67
781	93	183	4	2	0.50
782	93	183	2	2	1.00
783	57	92	2	2	1.00
		TOTAL	178	146	0.82

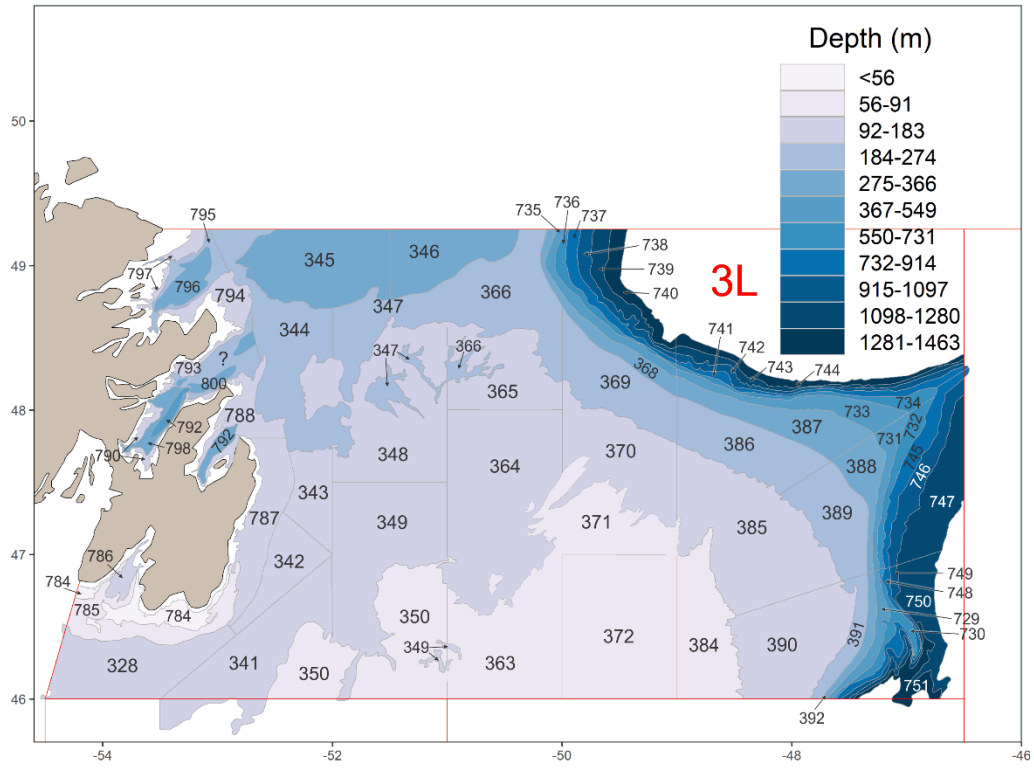


Figure 1. Stratification scheme for NAFO Division 3L.

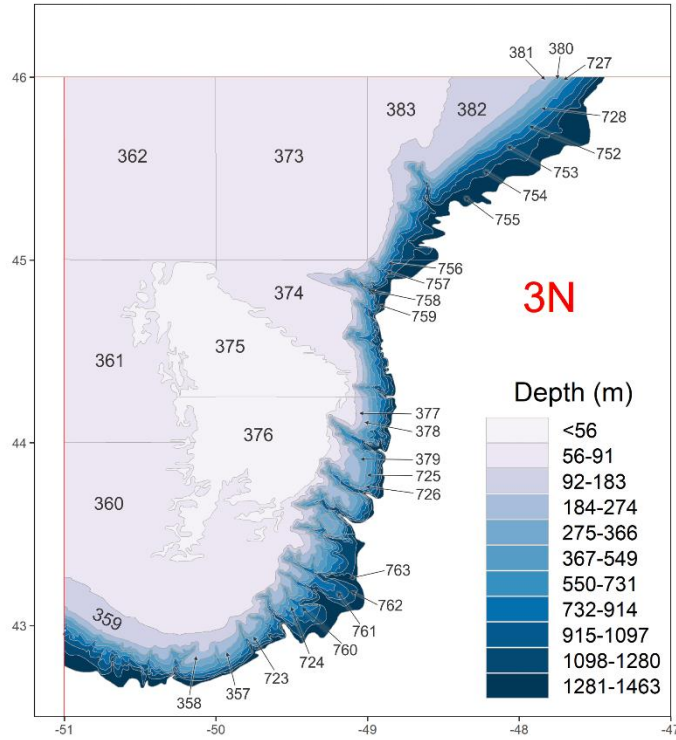


Figure 2. Stratification scheme for NAFO Division 3N.

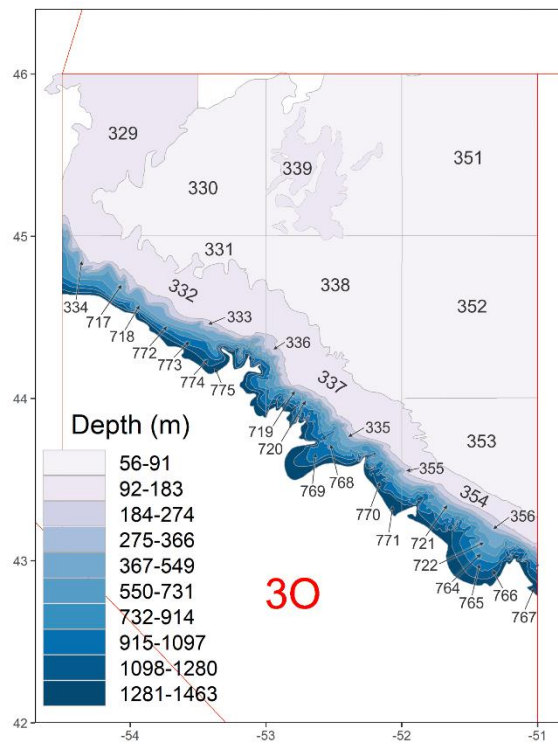


Figure 3. Stratification scheme for NAFO Division 3O.

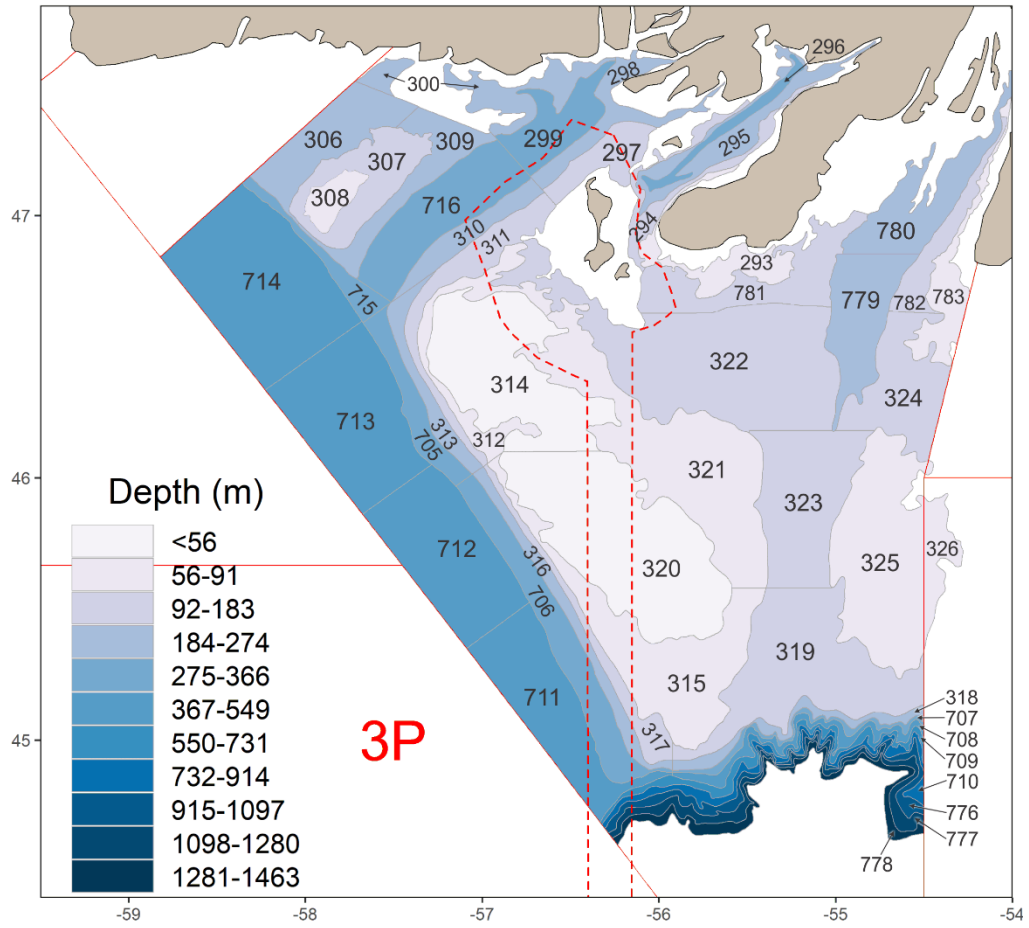


Figure 4. Stratification scheme for NAFO Subdivision 3Ps.

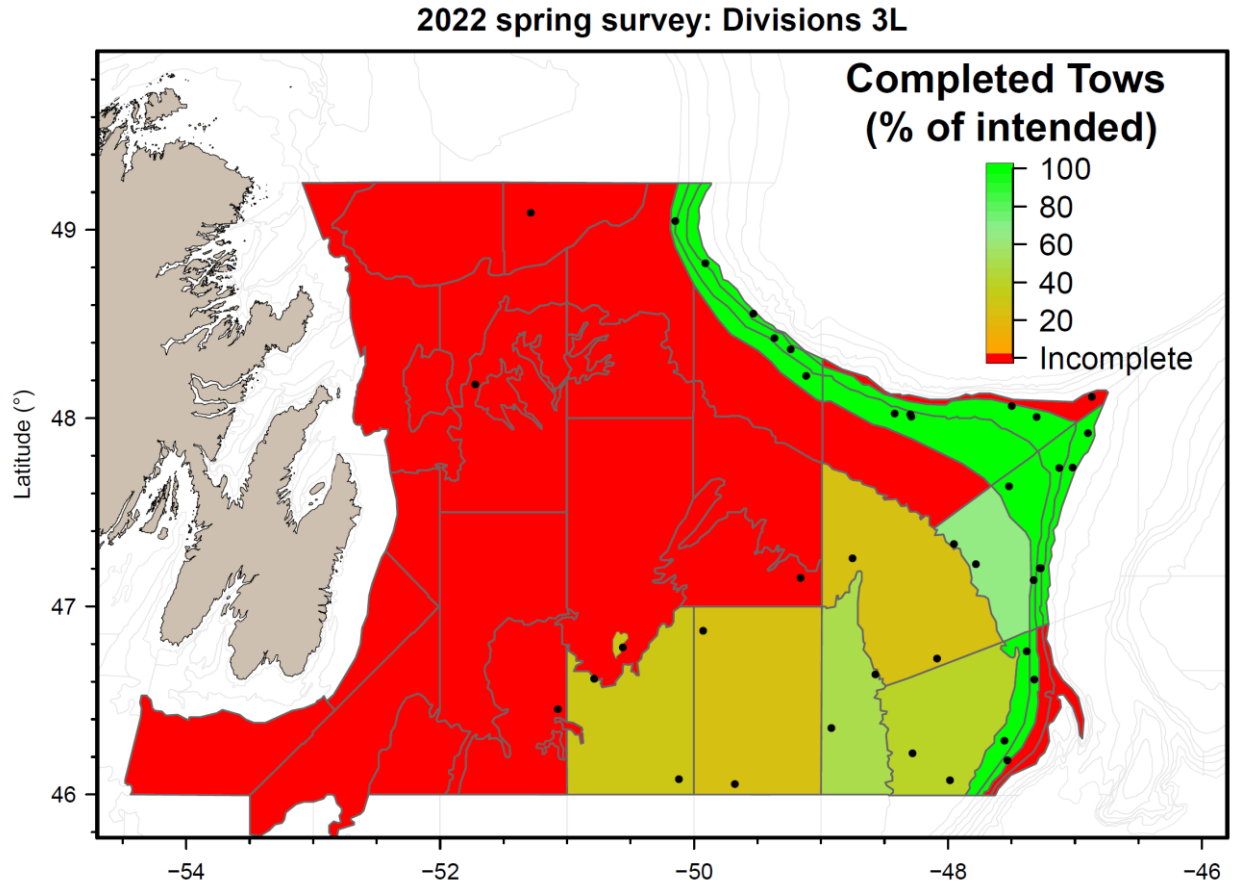


Figure 5. Spring survey coverage in 2022 for Division 3L. Strata with <2 sets (red) are incomplete. Fishing set positions (circles) are overlaid on the survey stratification scheme for the most recent survey.

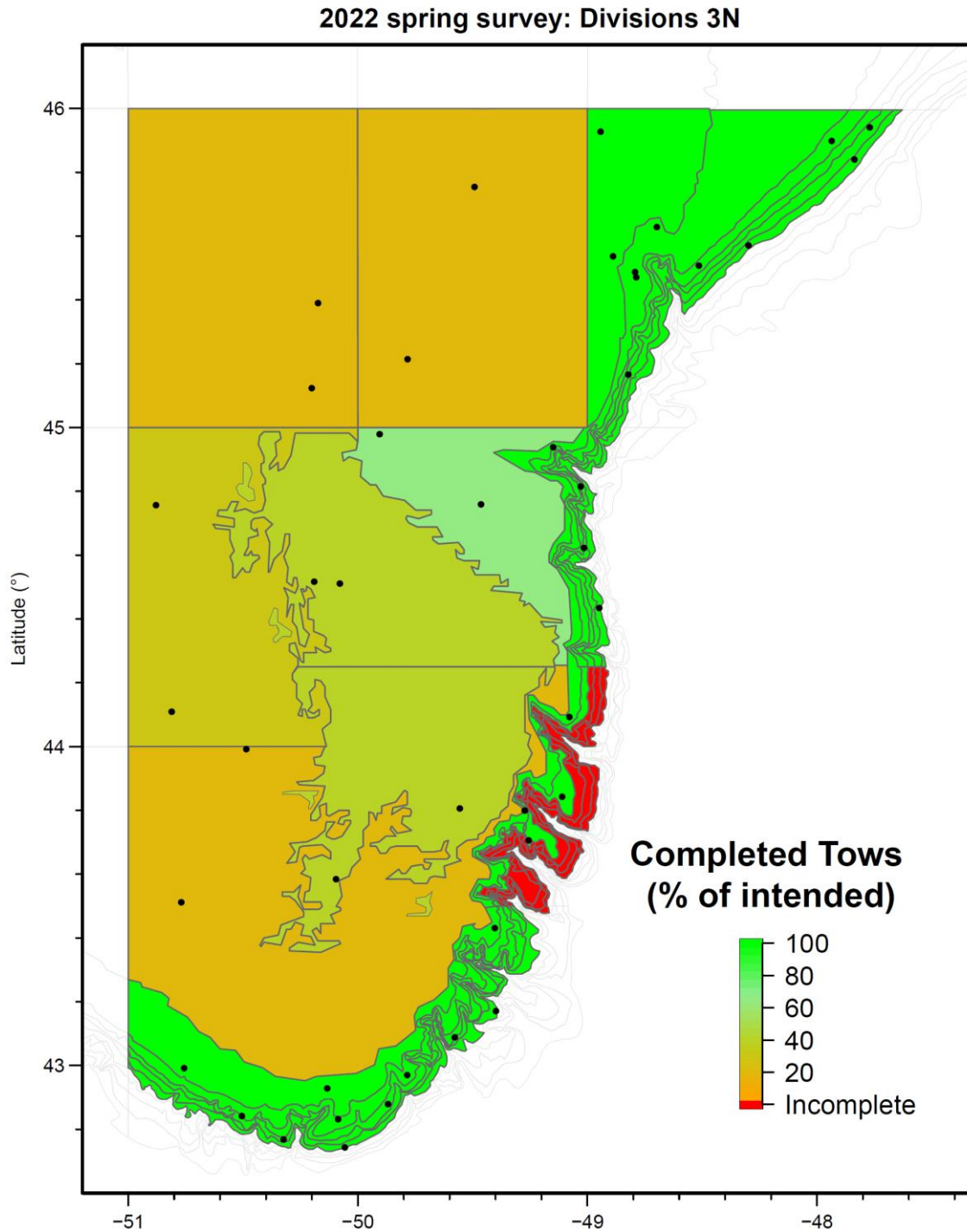


Figure 6. Spring survey coverage in 2022 for Division 3N. Strata with <2 sets (red) are incomplete. Fishing set positions (circles) are overlaid on the survey stratification scheme for the most recent survey.

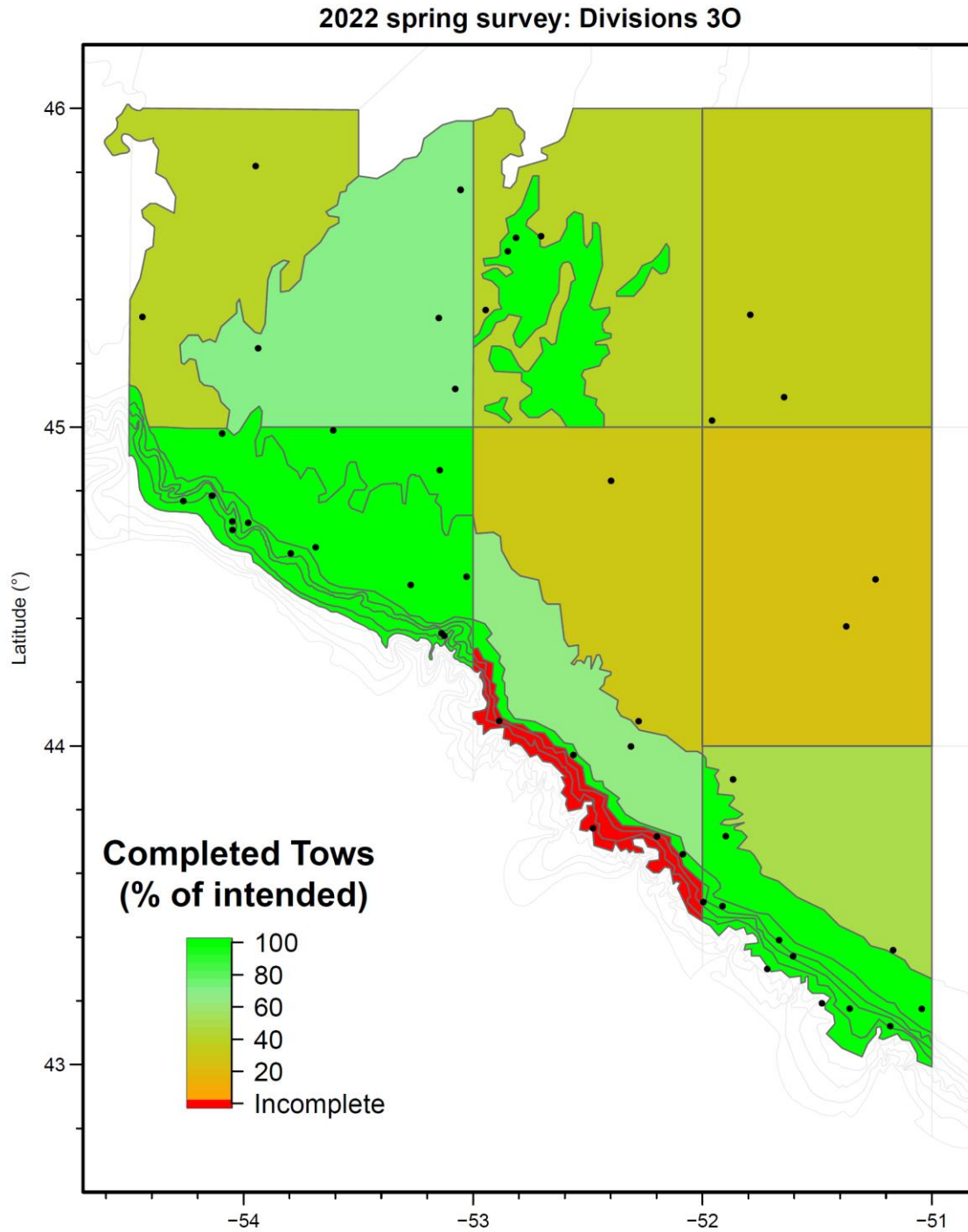


Figure 7. Spring survey coverage in 2022 for Division 30. Strata with <2 sets (red) are incomplete. Fishing set positions (circles) are overlaid on the survey stratification scheme for the most recent survey.

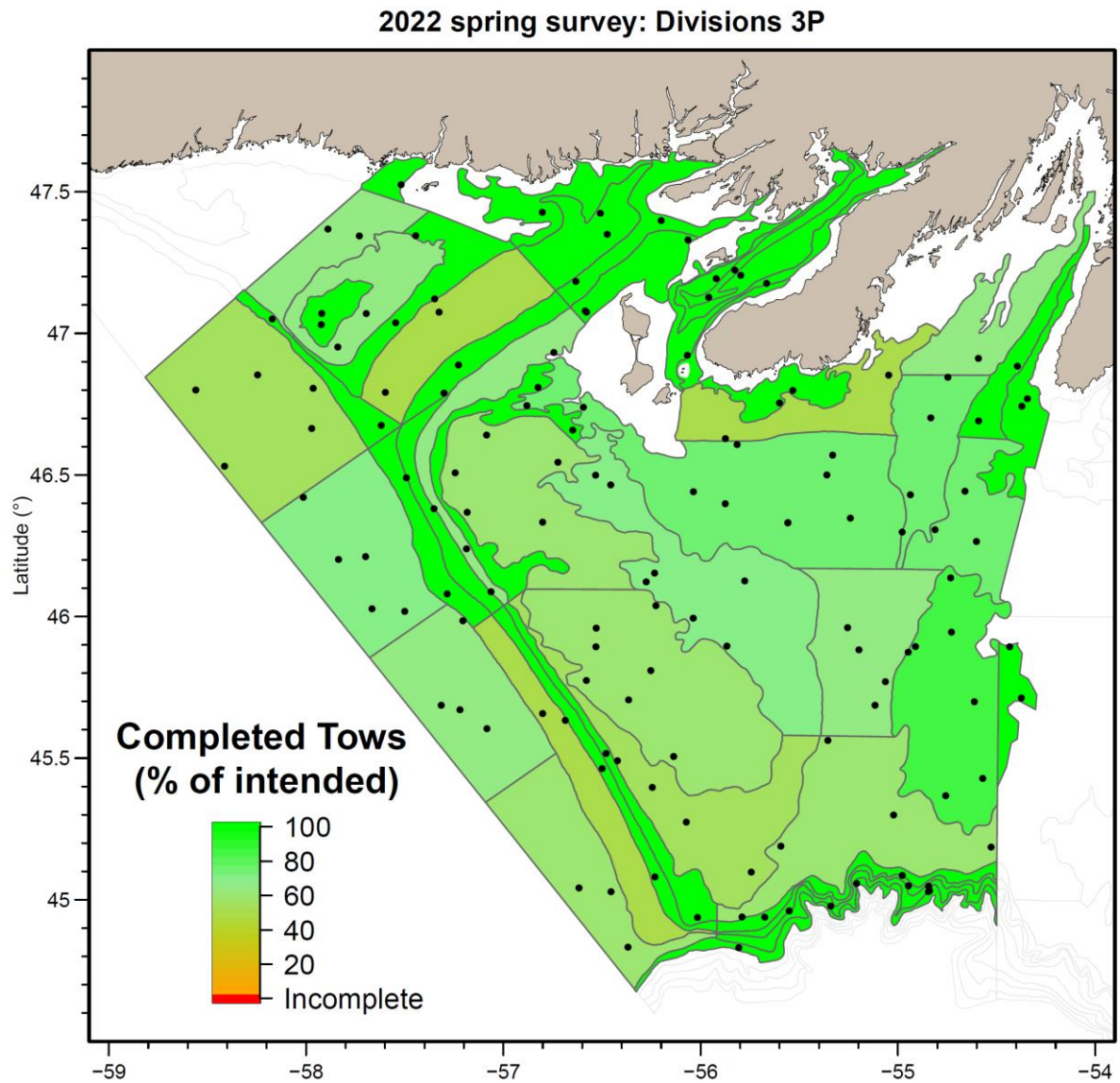


Figure 8. Spring survey coverage in 2022 for Subdivision 3Ps. All strata were completed. Fishing set positions (circles) are overlaid on the survey stratification scheme for the most recent survey.

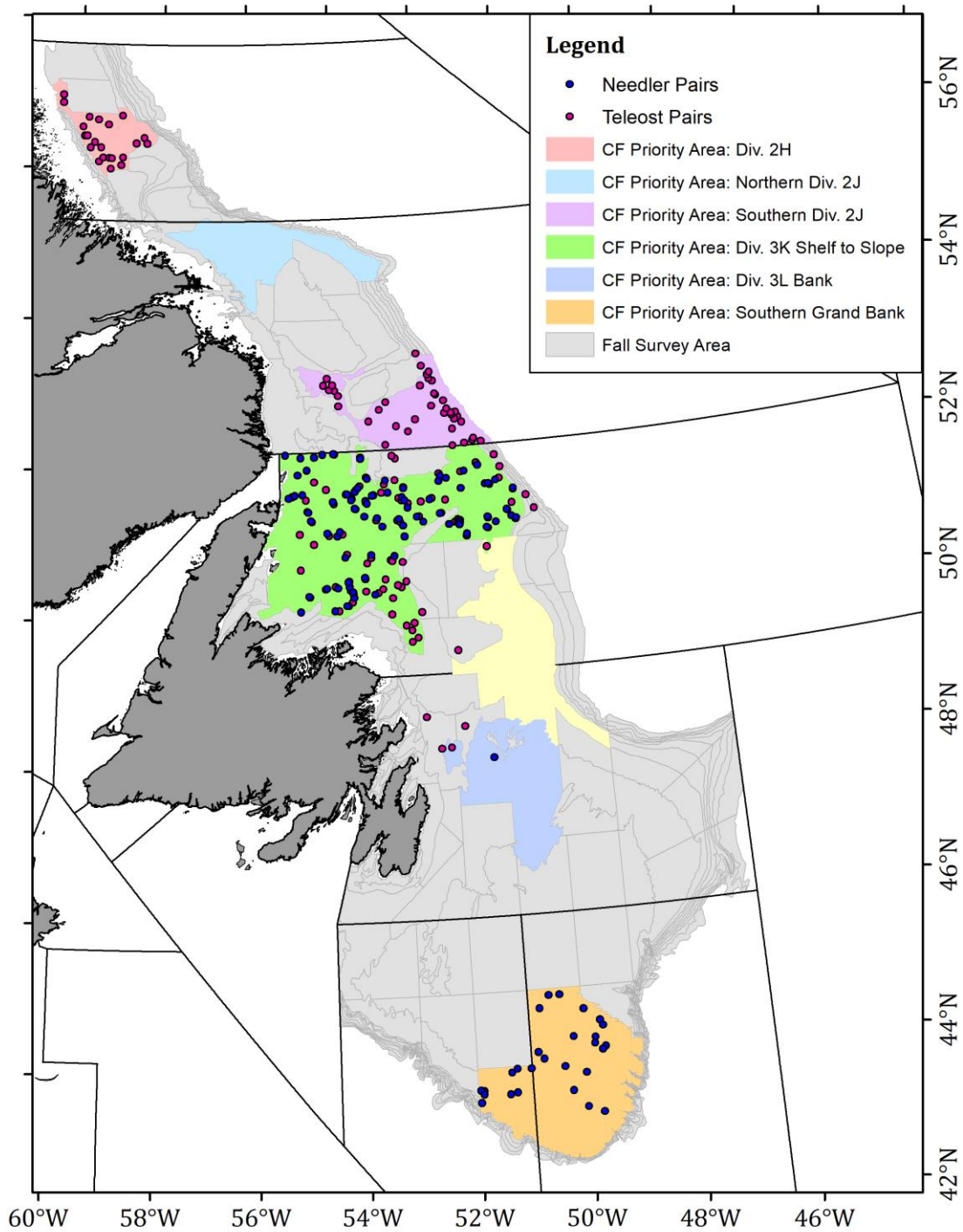


Figure 9. Comparative fishing in the Fall of 2022. This program replaced the standard multispecies survey for this one year. Achieved paired set locations are overlaid on the planned targeted areas. There are no fall survey indices in 2022.

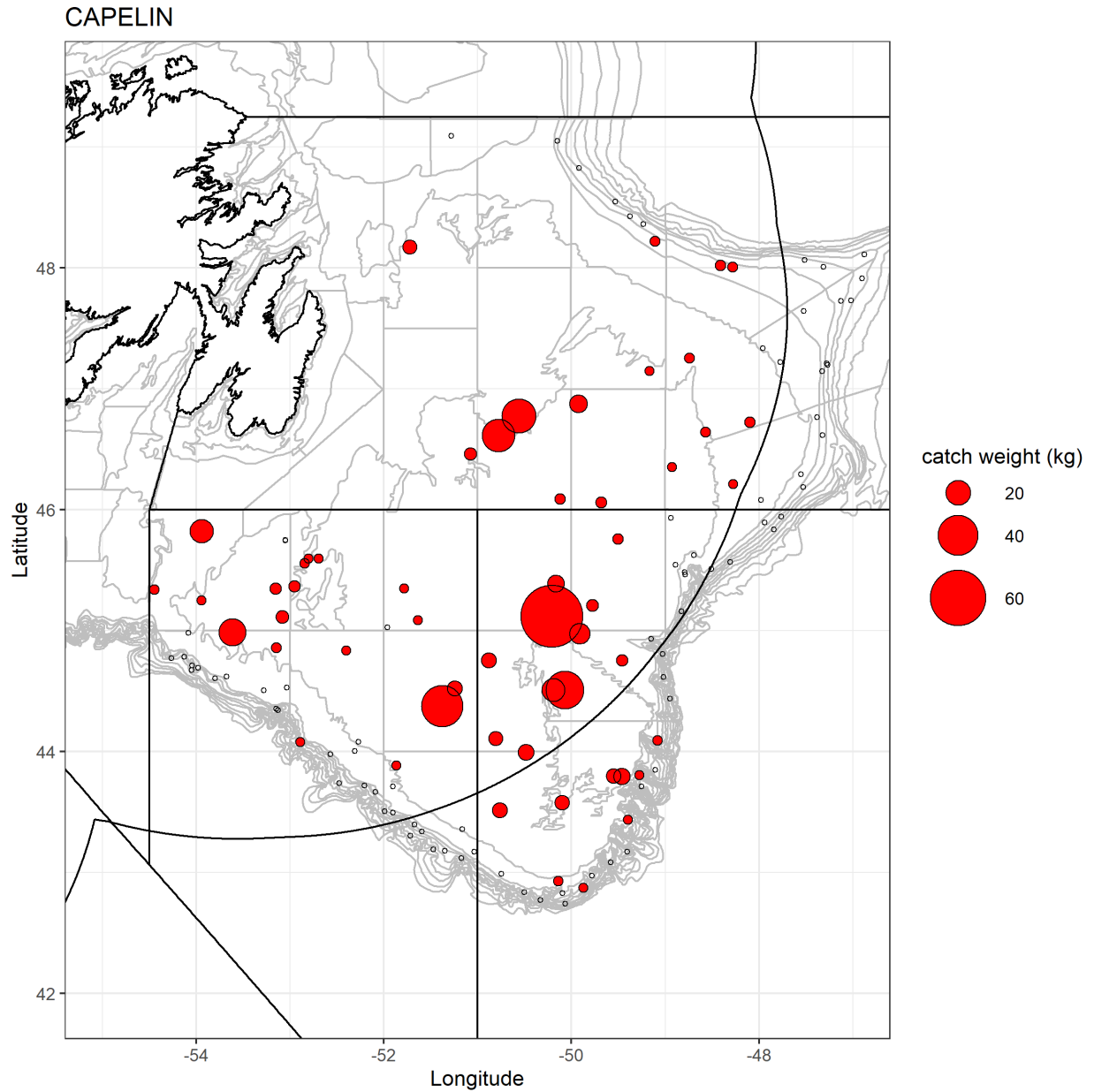


Figure 10. Distribution of capelin (*Mallotus villosus*) catches in Divs. 3LNO in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

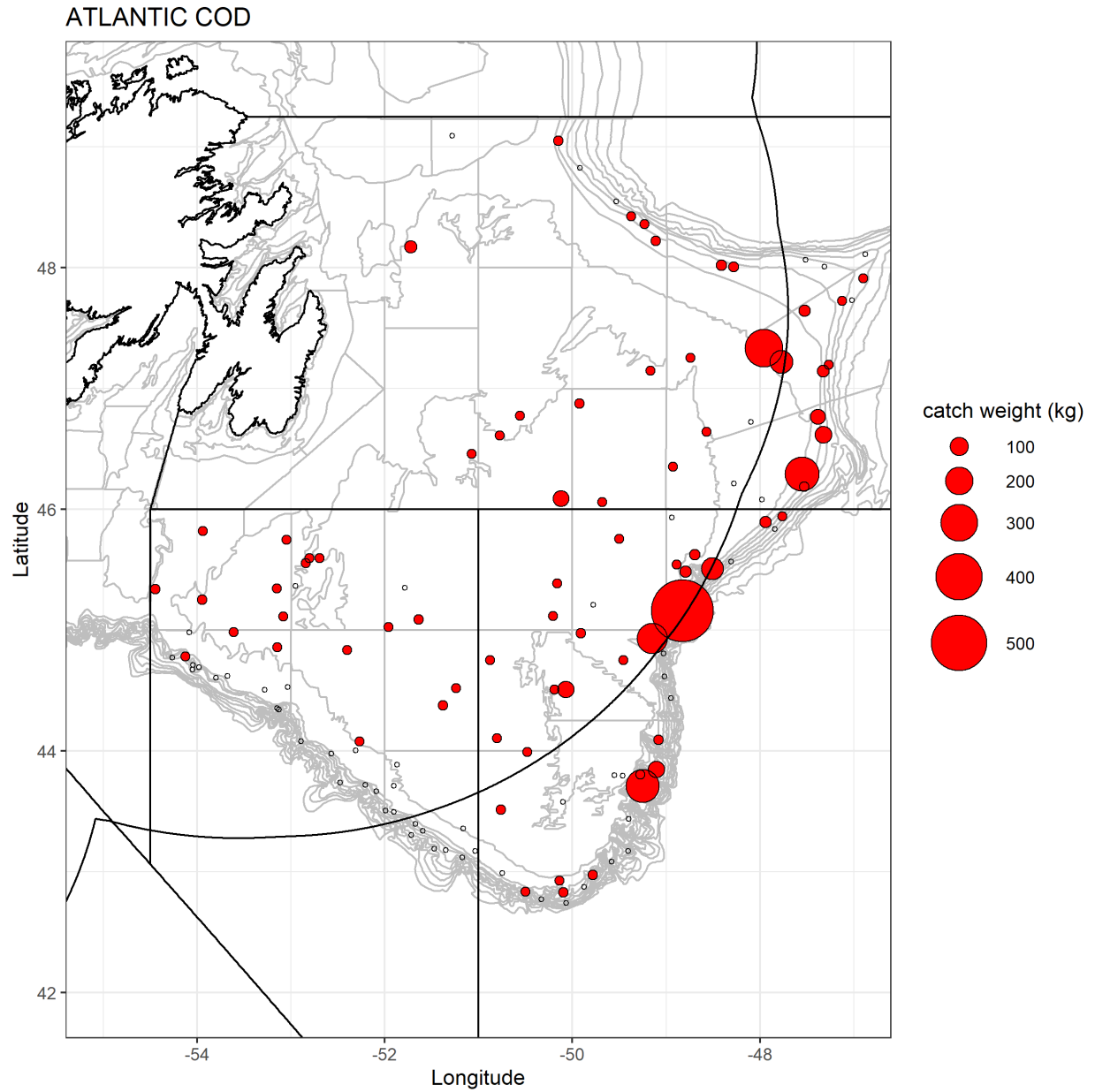


Figure 10. Distribution of Atlantic cod (*Gadus morhua*) catches in Divs. 3LNO in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

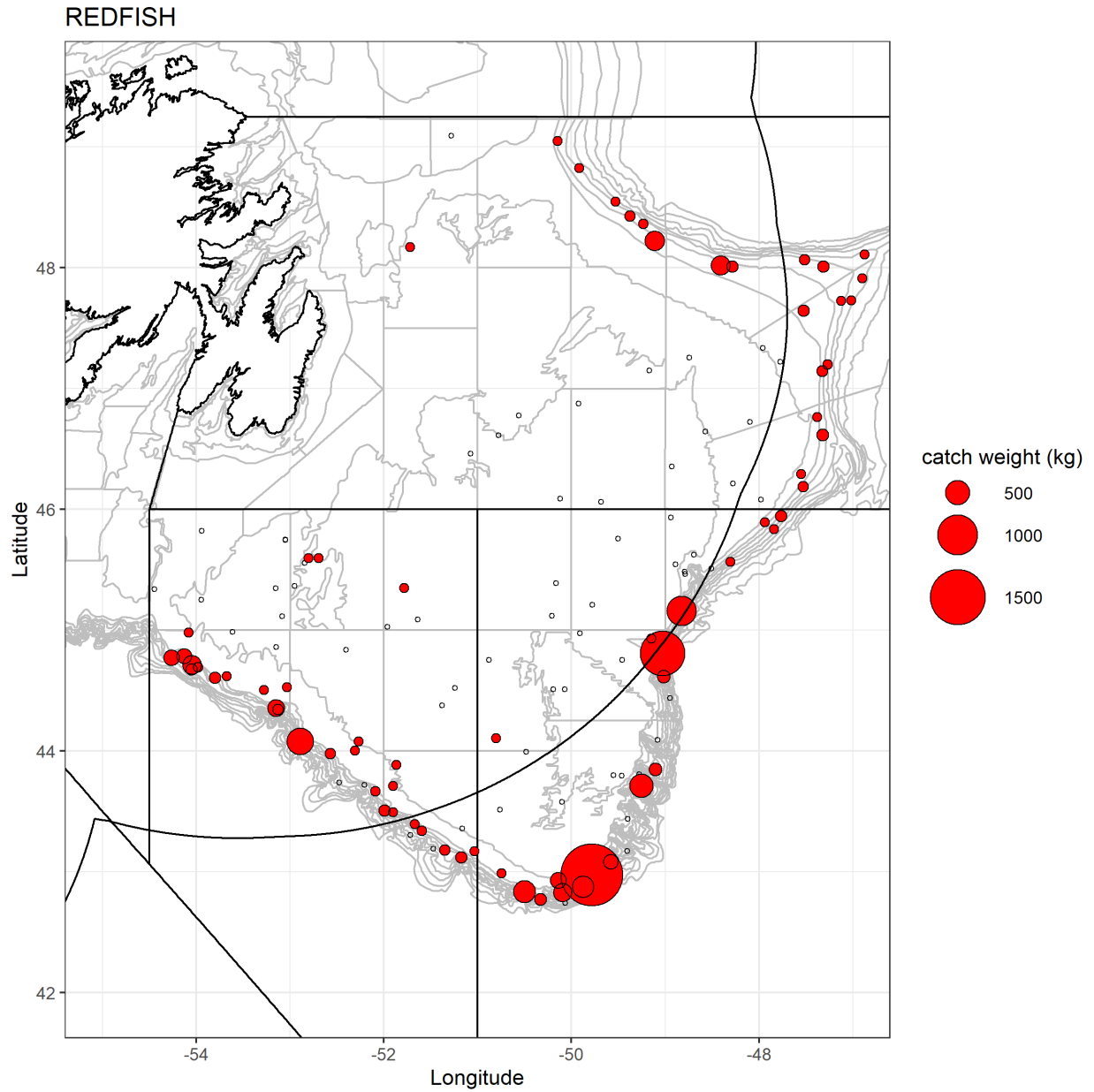


Figure 11. Distribution of Redfish (*Sebastes spp.*) catches in Divs. 3LNO in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

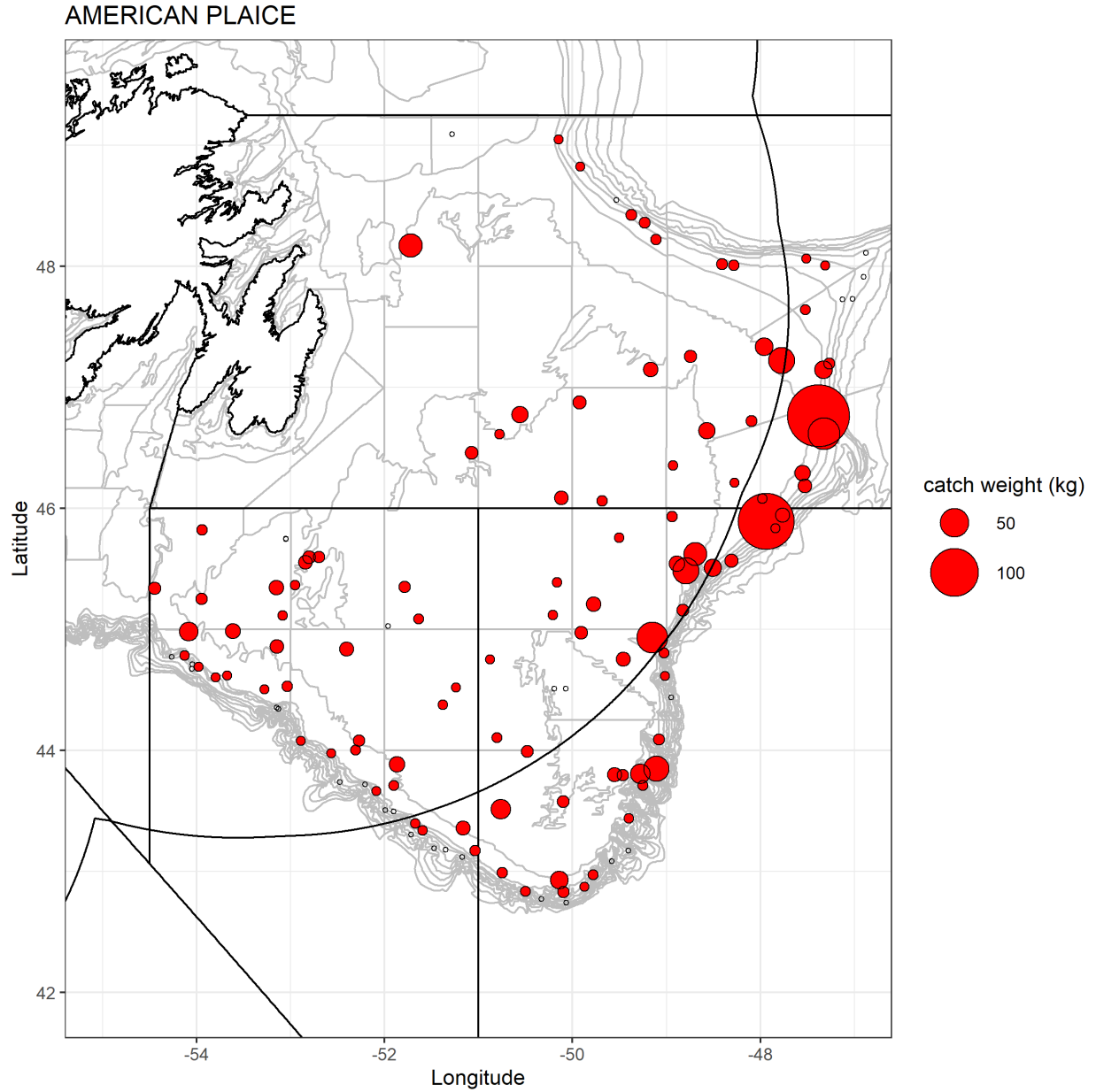


Figure 12. Distribution of American plaice (*Hippoglossoides platessoides*) catches in Divs. 3LNO in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

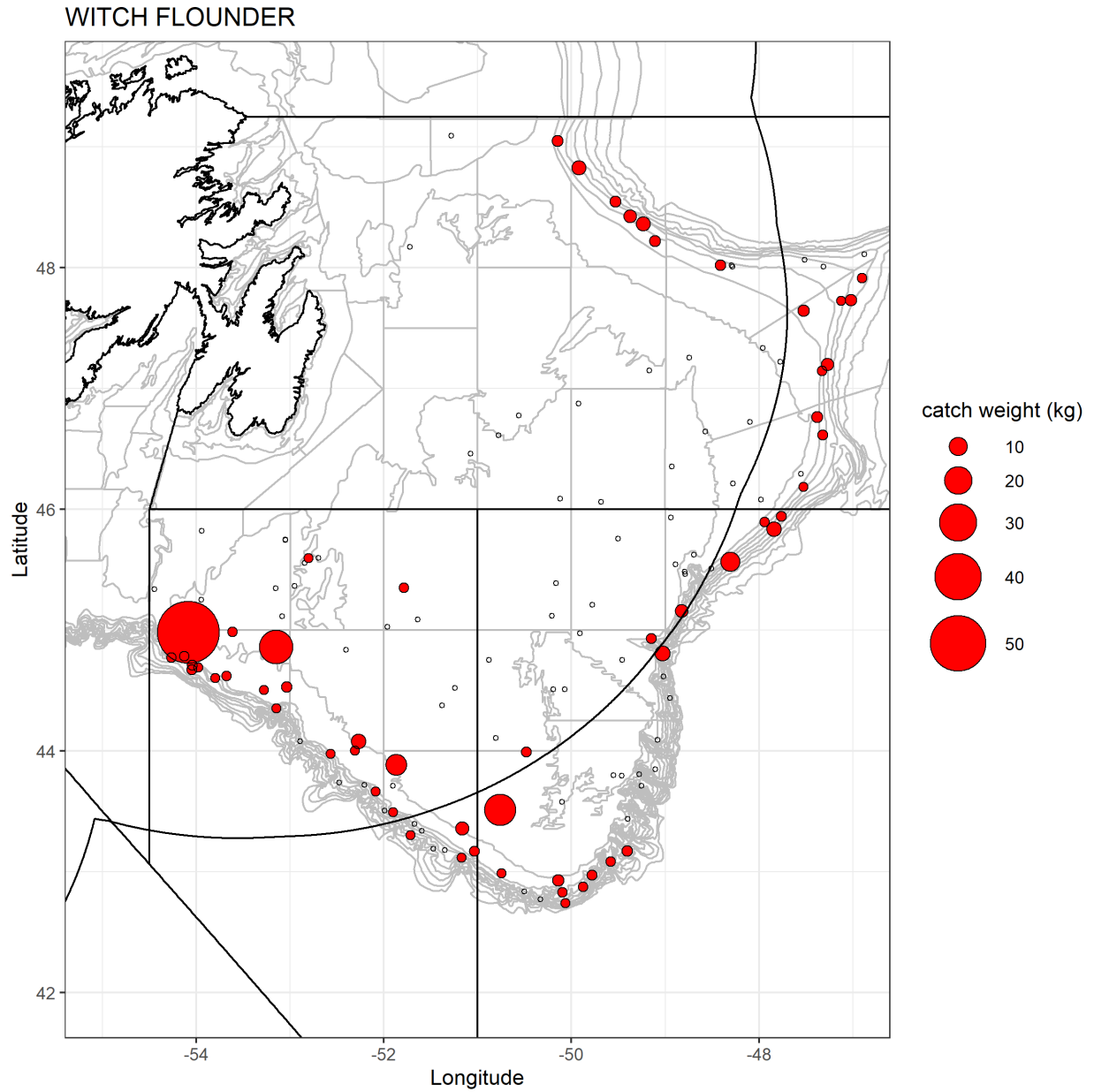


Figure 13. Distribution of Witch flounder (*Glyptocephalus cynoglossus*) catches in Divs. 3LNO in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

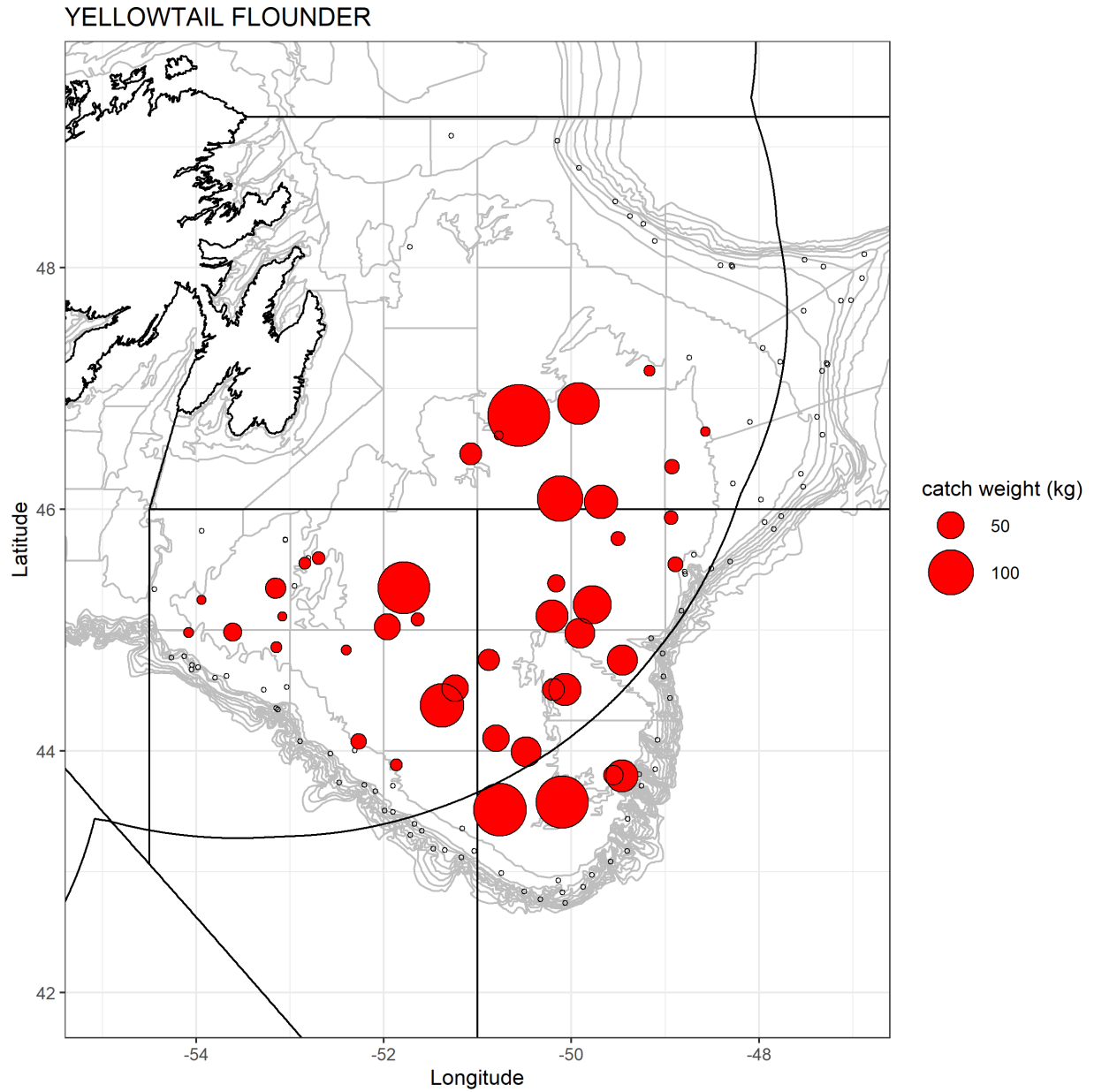


Figure 14. Distribution of Yellowtail flounder (*Limanda ferruginea*) catches in Divs. 3LNO in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

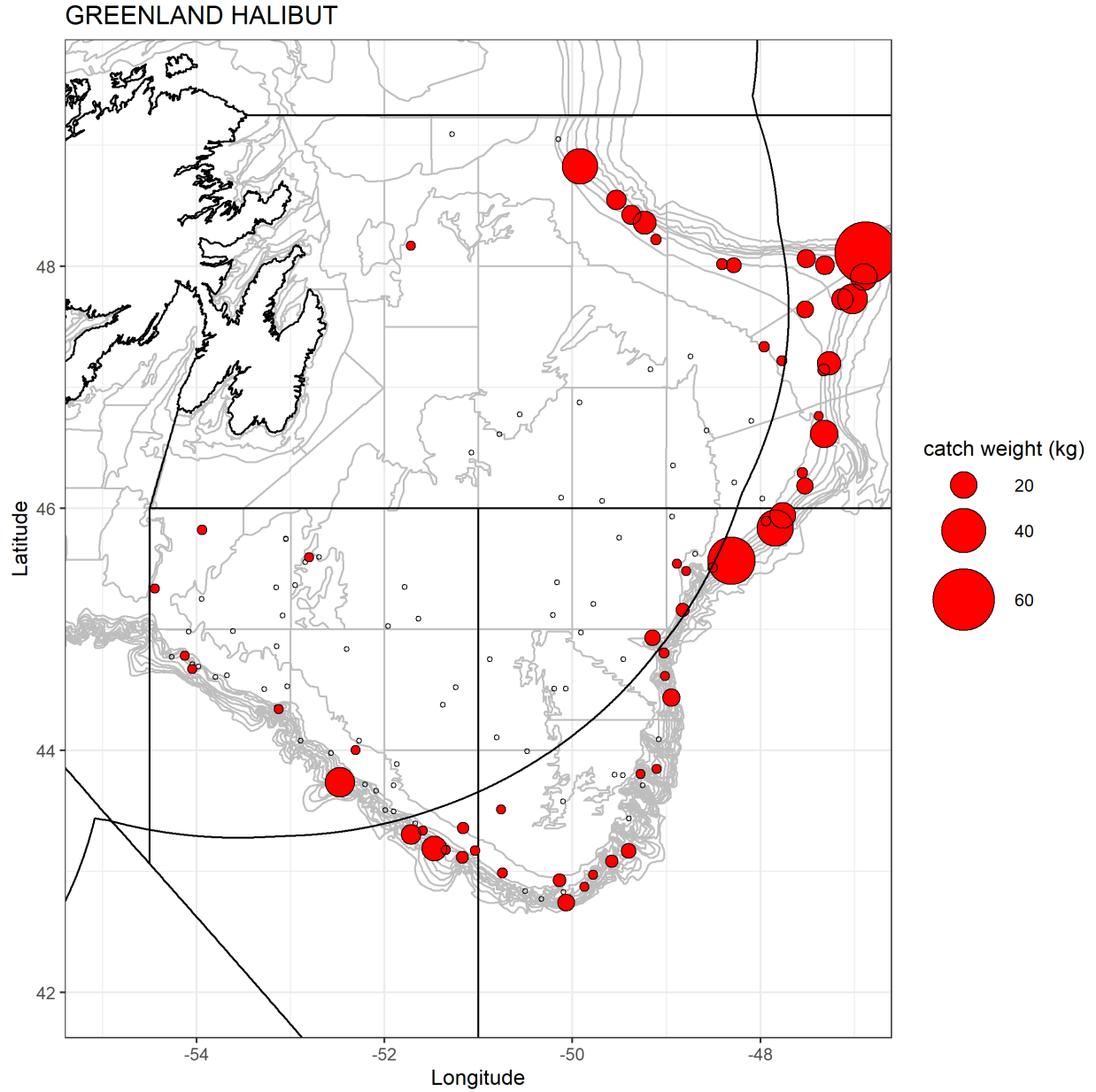


Figure 15. Distribution of Greenland halibut (*Reinardtius hippoglossoides*) catches in Divs. 3LNO in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

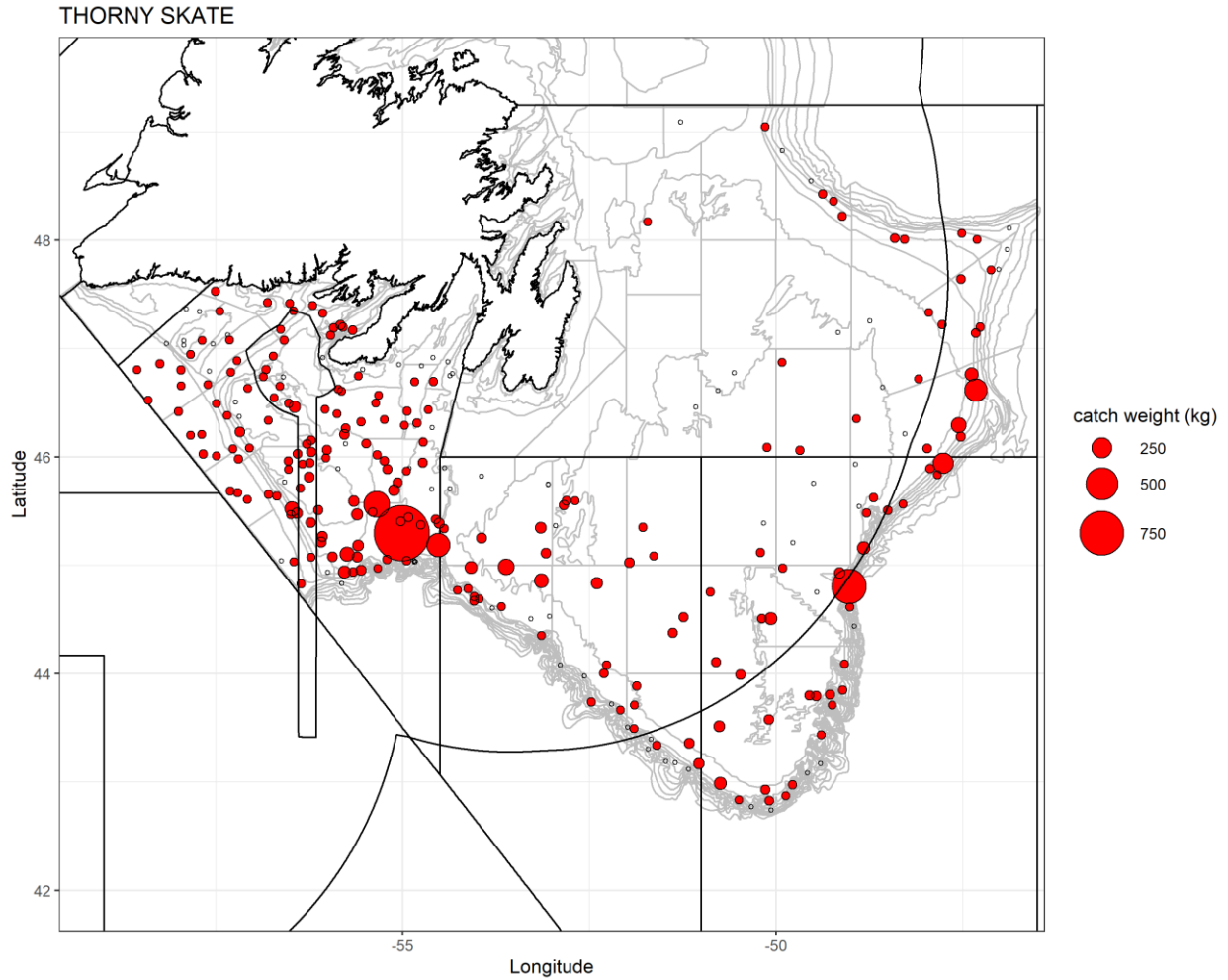


Figure 16. Distribution of Thorny skate (*Amblyraja radiata*) catches in Divs. 3LNOPs in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.

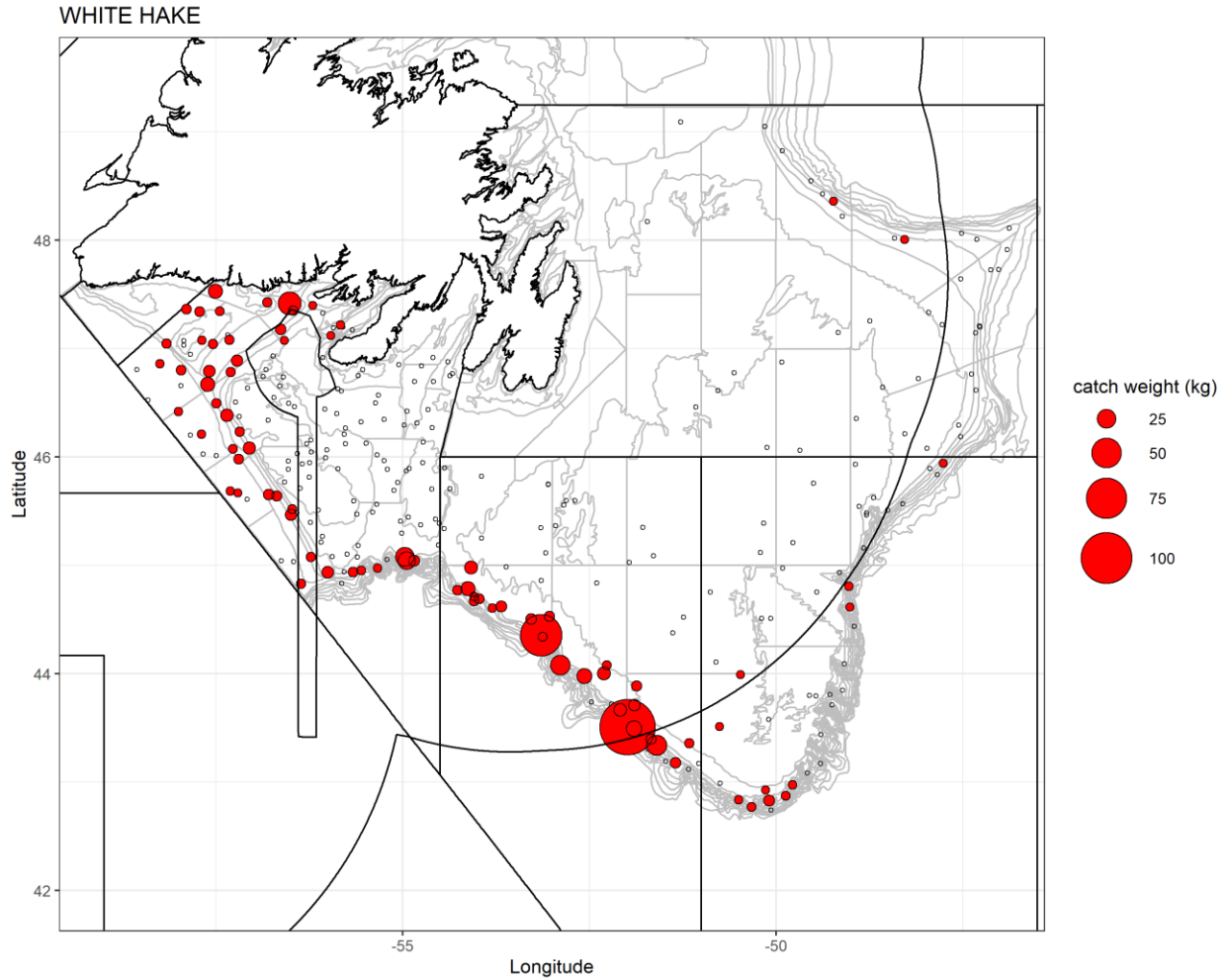


Figure 17. Distribution of White hake (*Urophycis tenuis*) catches in Divs. 3LNOPs in Spring 2022. Note that catch weights are in Cabot-units and should not be directly compared to previous spring indices. Open circles indicate sets with zero catch of this species.