NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

Improving NFI-based living biomass change estimates using Global Forest Change data

Christian W. Mohr, Johannes Breidenbach, Gunnhild Søgaard, Oliver Moen Snoksrud, Rune Eriksen • 22/05/2024

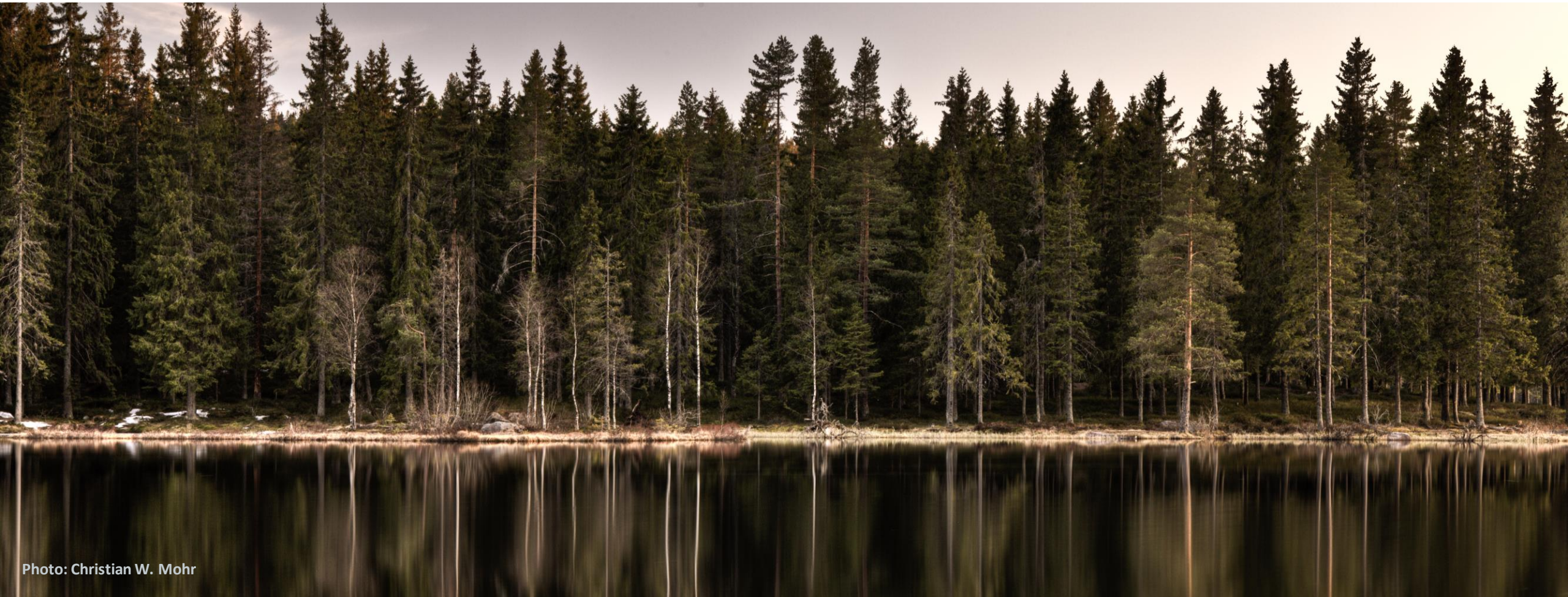
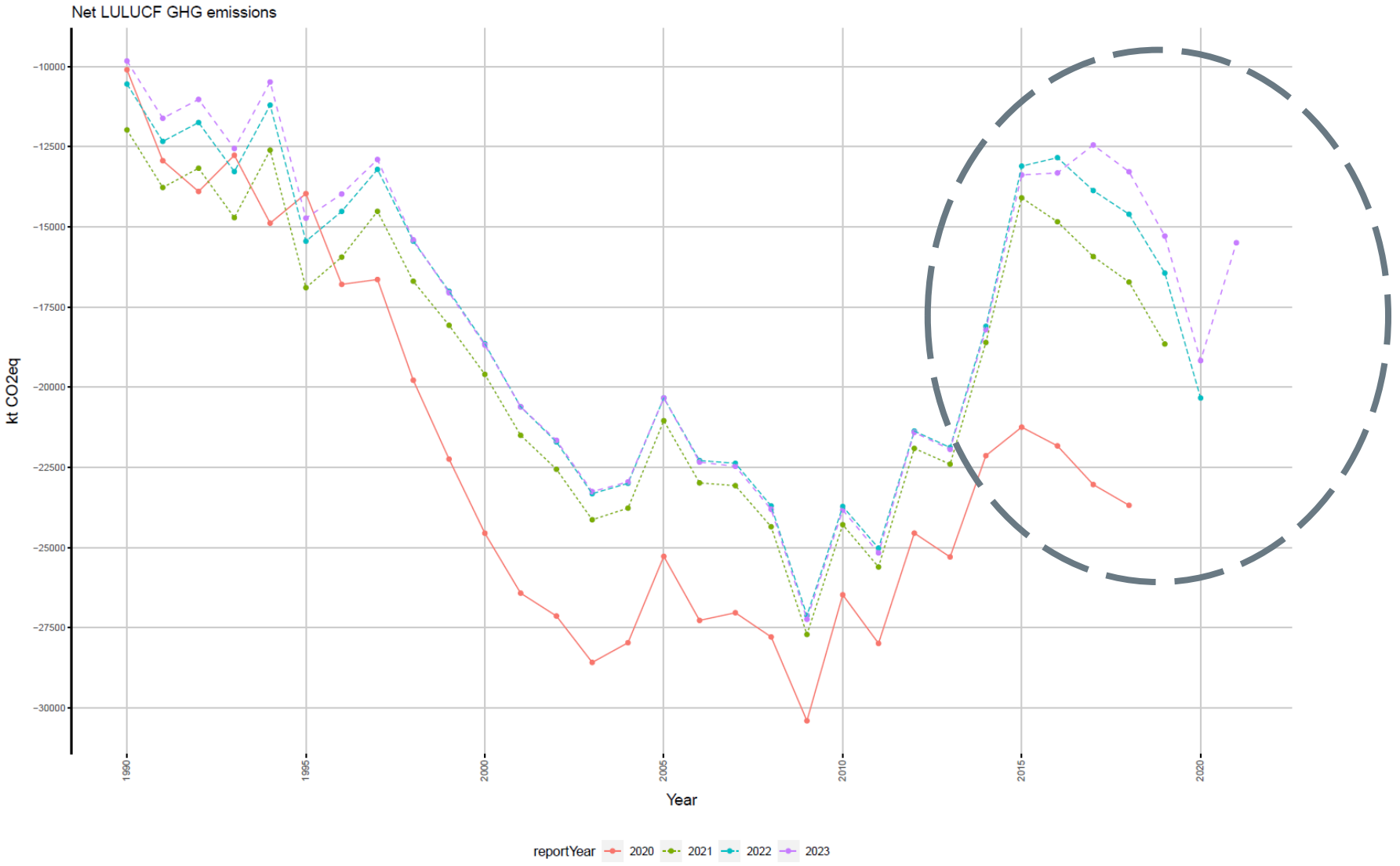
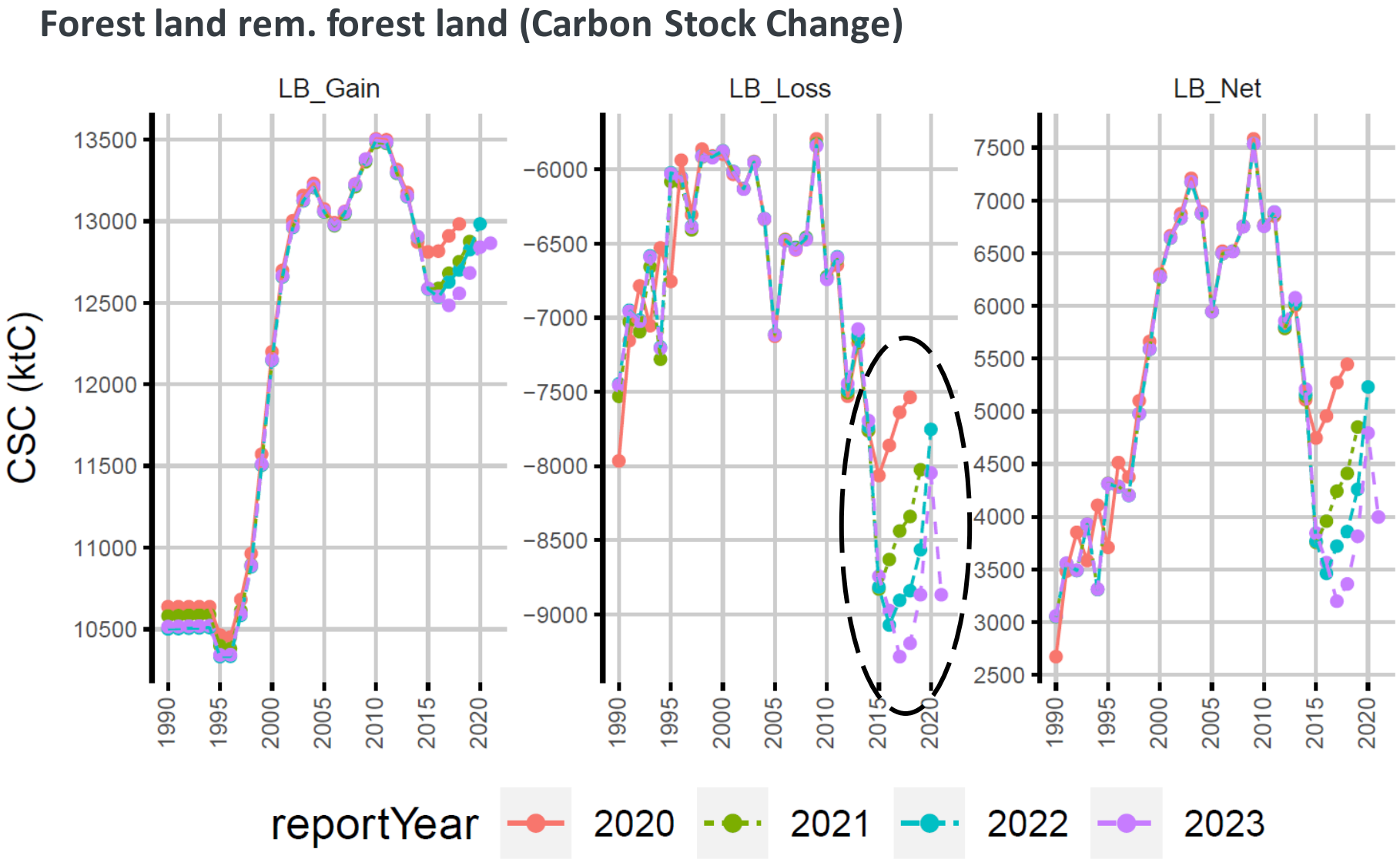


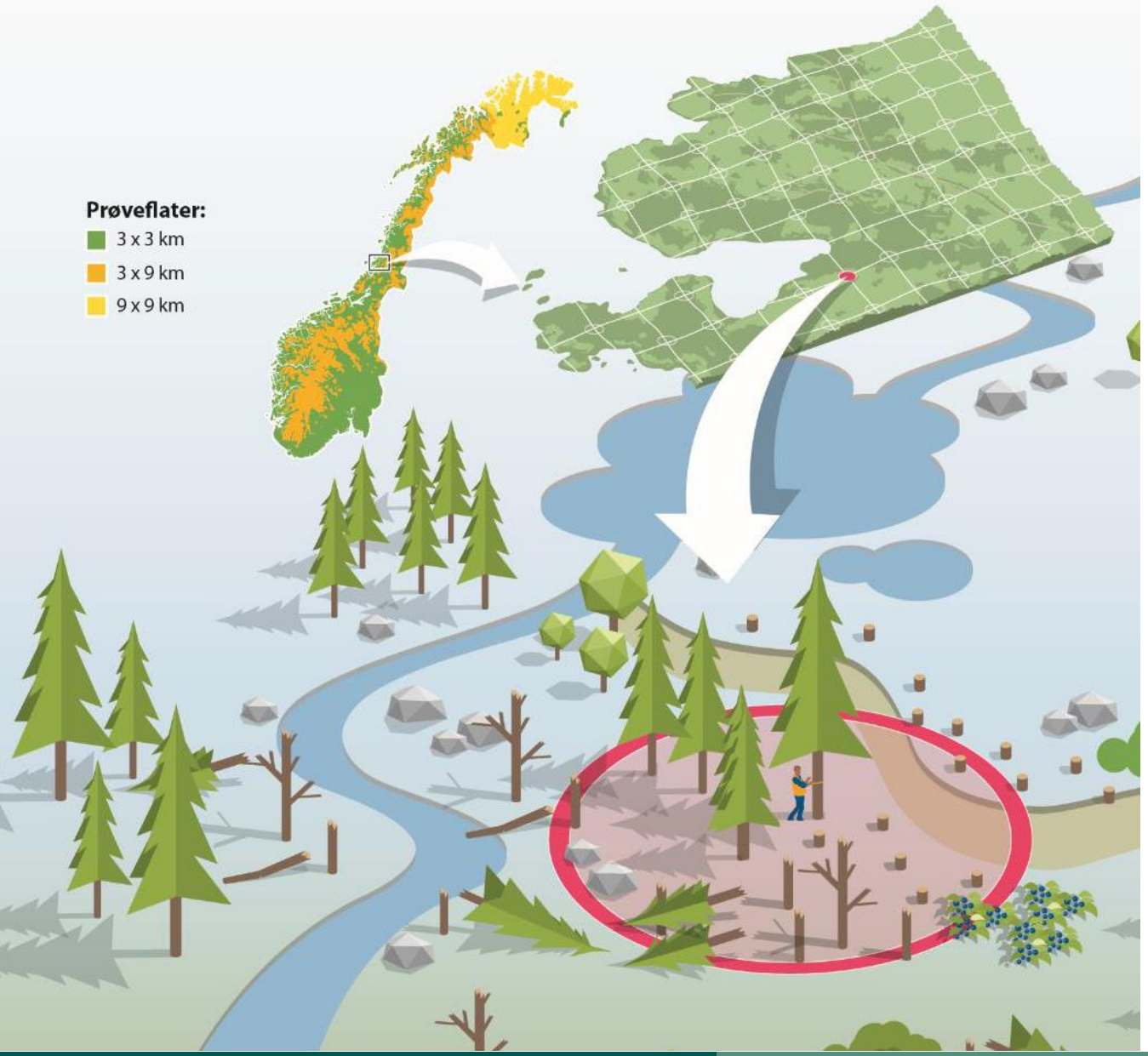
Photo: Christian W. Mohr

Recalculations for LULUCF



Largest recalculations are for living biomass losses





Norwegian NFI sampling

- 22008 permanent plots
  - approx. 13000 are forest plots
- 1986 – (2022)
- Grid size: 3x3 km, 3 x 9 km, 9 x 9 km
- 1/5th of the plot are survayed each year
  - aerial observation or field monitoring (if there are trees)
  - systamatic homogeneous sampling since 1994.

NFI data structure

Year	PANEL_1	PANEL_2	PANEL_3	PANEL_4	PANEL_5	
1986-1993	1	1	1	1	1	observatons
1994	2					gap filled
1995		2				
1996			2			
1997				2		
1998					2	observatons
1999	3					gap filled
2000		3				
2001			3			
2002				3		
2003					3	observatons
2004	4					gap filled
2005		4				
2006			4			
2007				4		
2008					4	observatons
2009	5					gap filled
2010		5				
2011			5			
2012				5		
2013					5	observatons
2014	6					gap filled
2015		6				
2016			6			
2017				6		
2018					6	observatons
2019	7					gap filled
2020		7				
2021			7			

NFI data structure

Year	PANEL_1	PANEL_2	PANEL_3	PANEL_4	PANEL_5
1986-1993	1	1	1	1	1
1994	2				
1995		2			
1996			2		
1997				2	
1998					2
1999	3				
2000		3			
2001			3		
2002				3	
2003					3
2004	4				
2005		4			
2006			4		
2007				4	
2008					4
2009	5				
2010		5			
2011			5		
2012				5	
2013					5
2014	6				
2015		6			
2016			6		
2017				6	
2018					6
2019	7				
2020		7			
2021			7		

Interpolation

NFI data structure

Year	PANEL_1	PANEL_2	PANEL_3	PANEL_4	PANEL_5
1986-1993	1	1	1	1	1
1994	2				
1995		2			
1996			2		
1997				2	
1998					2
1999	3				
2000		3			
2001			3		
2002				3	
2003					3
2004	4				
2005		4			
2006			4		
2007				4	
2008					4
2009	5				
2010		5			
2011			5		
2012				5	
2013					5
2014	6				
2015		6			
2016			6		
2017				6	
2018					6
2019	7				
2020		7			
2021			7		

Interpolation

Extrapolation (average gains/loss rate)

NFI data structure

NIR2021

Year	PANEL_1	PANEL_2	PANEL_3	PANEL_4	PANEL_5
1986-1993	1	1	1	1	1
1994	2				
1995		2			
1996			2		
1997				2	
1998					2
1999	3				
2000		3			
2001			3		
2002				3	
2003					3
2004	4				
2005		4			
2006			4		
2007				4	
2008					4
2009	5				
2010		5			
2011			5		
2012				5	
2013					5
2014	6				
2015		6			
2016			6		
2017				6	
2018					6
2019	7				

NIR2022

Year	PANEL_1	PANEL_2	PANEL_3	PANEL_4	PANEL_5
1986-1993	1	1	1	1	1
1994	2				
1995		2			
1996			2		
1997				2	
1998					2
1999	3				
2000		3			
2001			3		
2002				3	
2003					3
2004	4				
2005		4			
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2017				6	
2018					6
2019	7				
2020		7			

NIR2023

Year	PANEL_1	PANEL_2	PANEL_3	PANEL_4	PANEL_5
1986-1993	1	1	1	1	1
1994	2				
1995		2			
1996			2		
1997				2	
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1999	3				
2000		3			
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2004	4				
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2011			5		
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2019	7				
2020		7			
2021			7		

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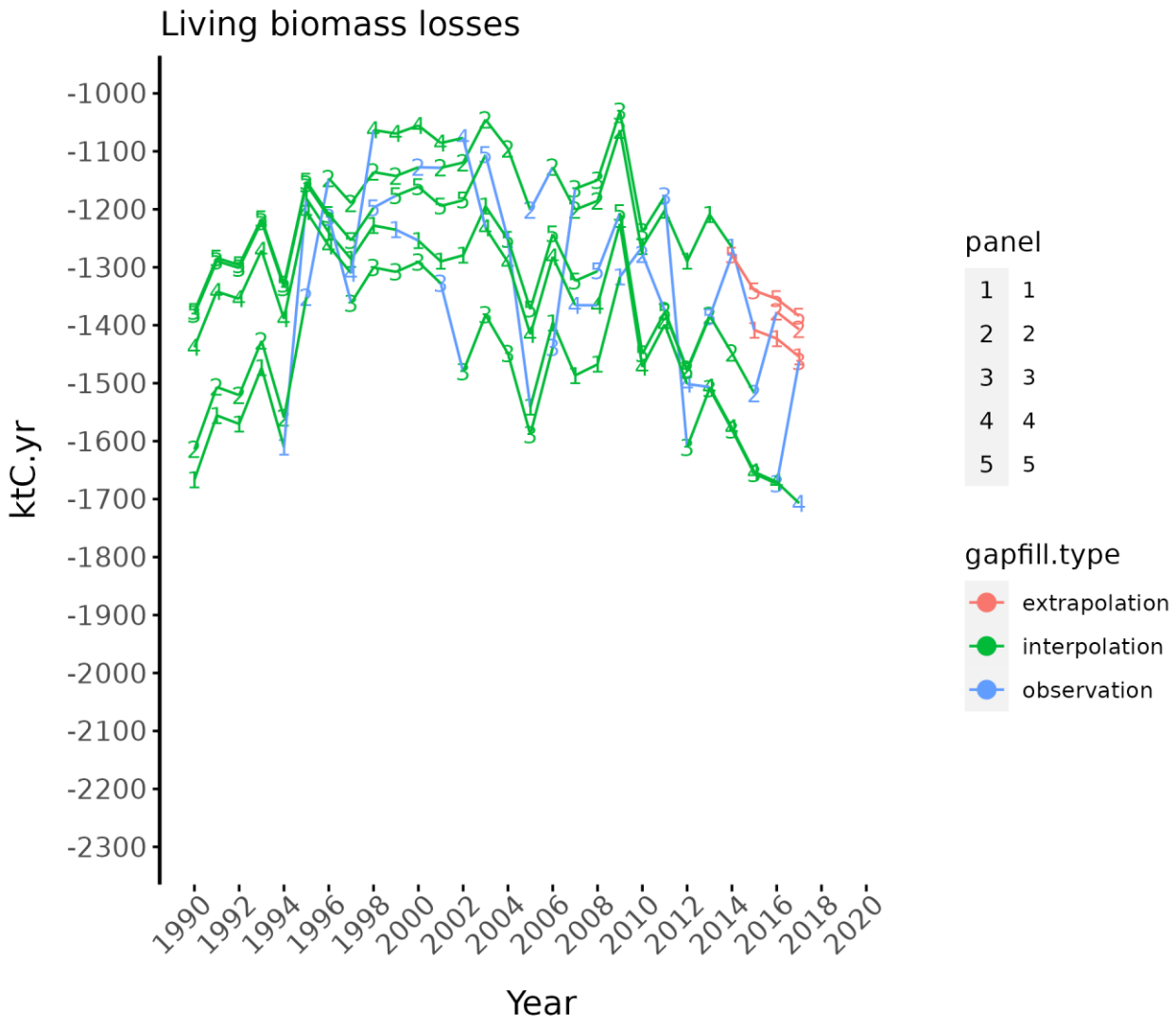
Living biomass losses
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-2200
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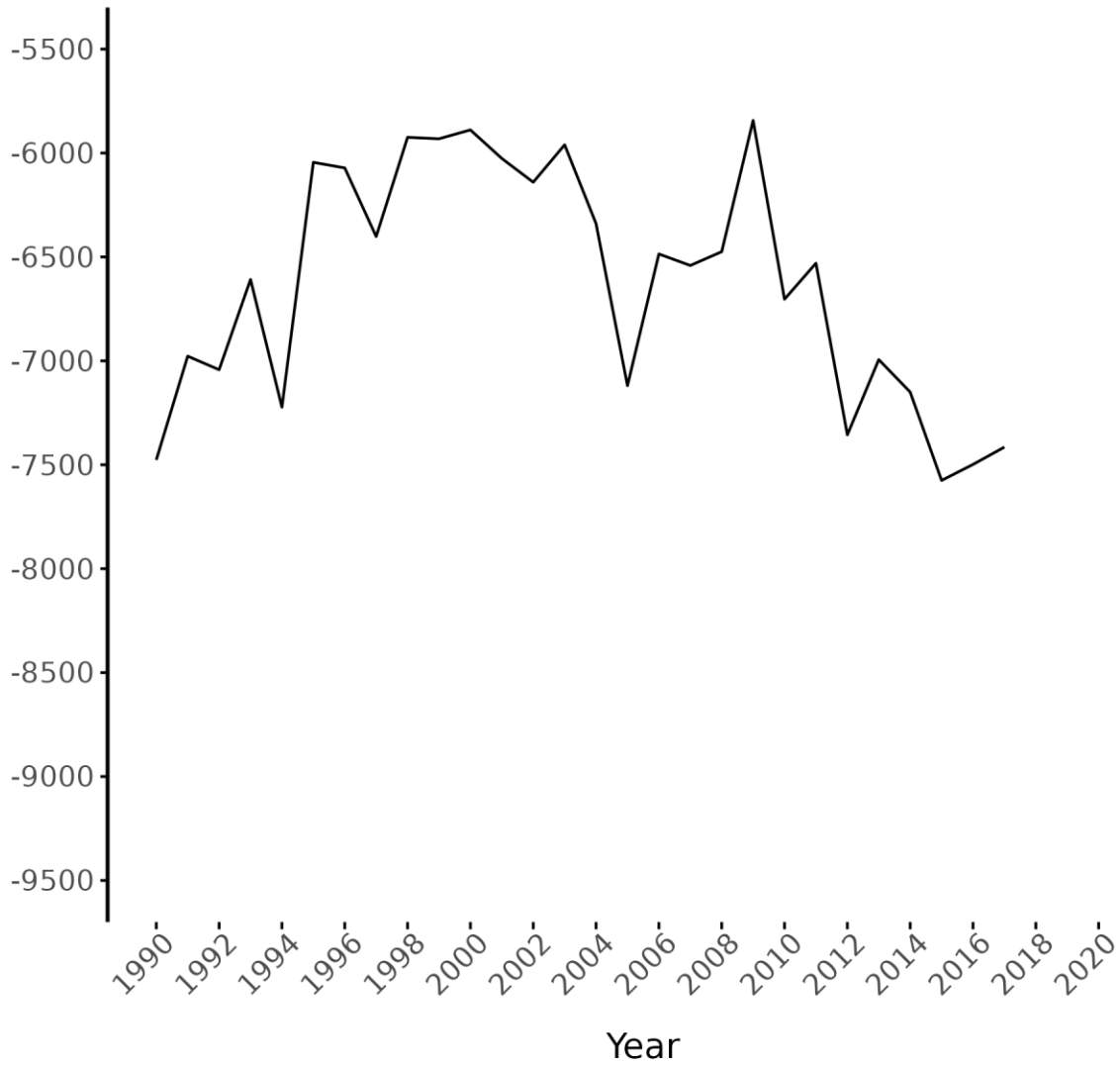
gapfill.type
extrapolation
interpolation
observation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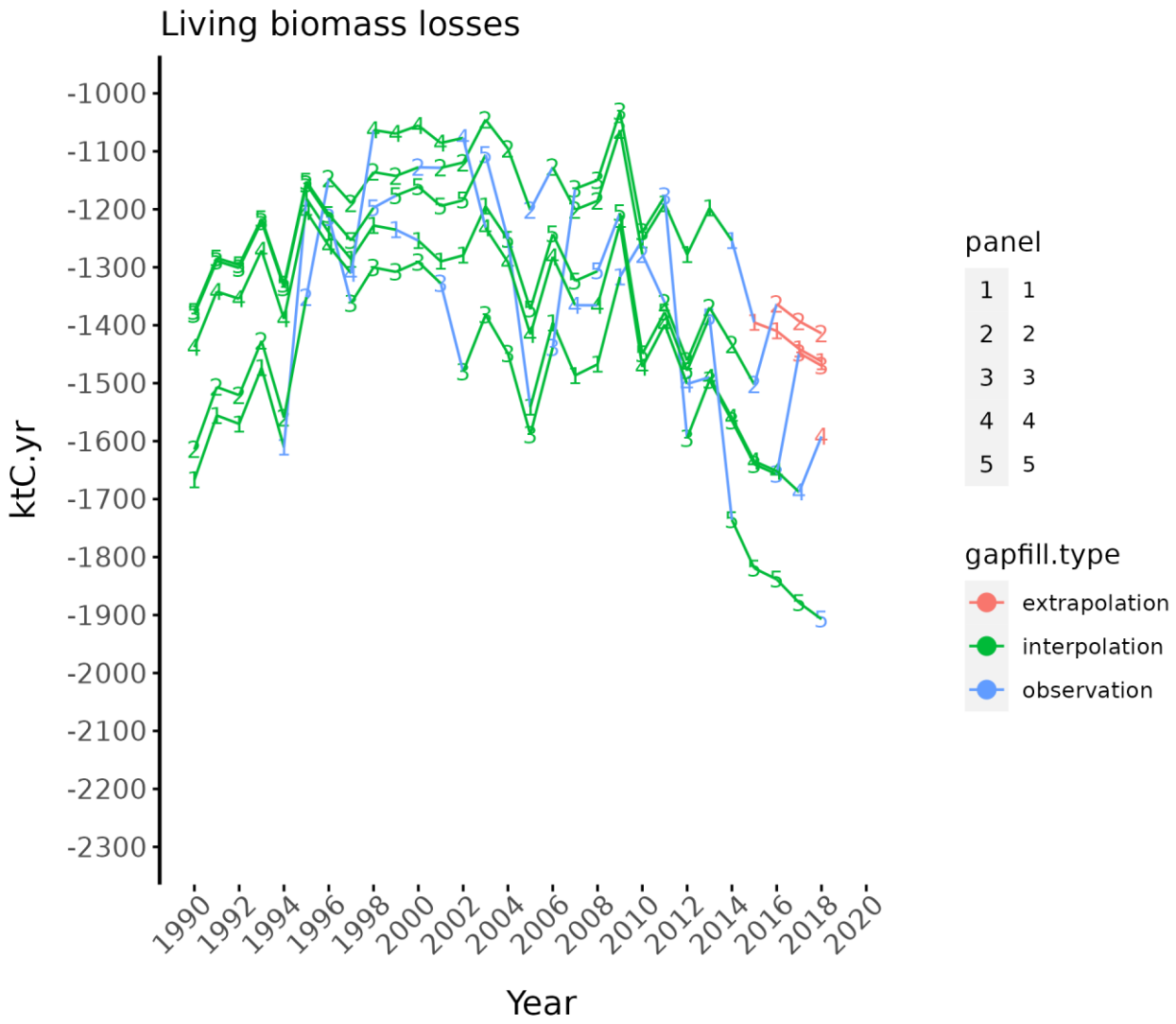
Living biomass losses
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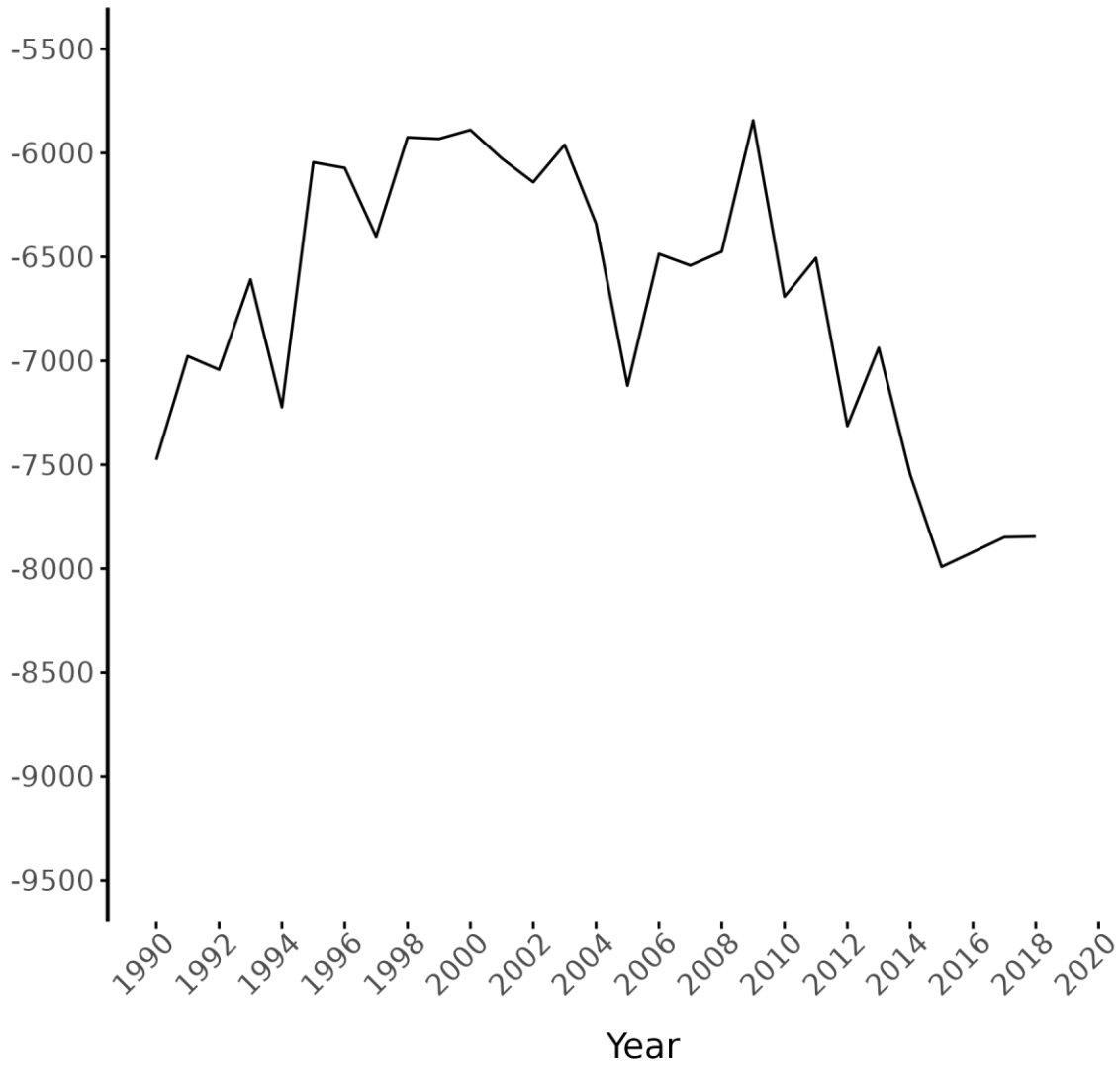
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Living biomass losses
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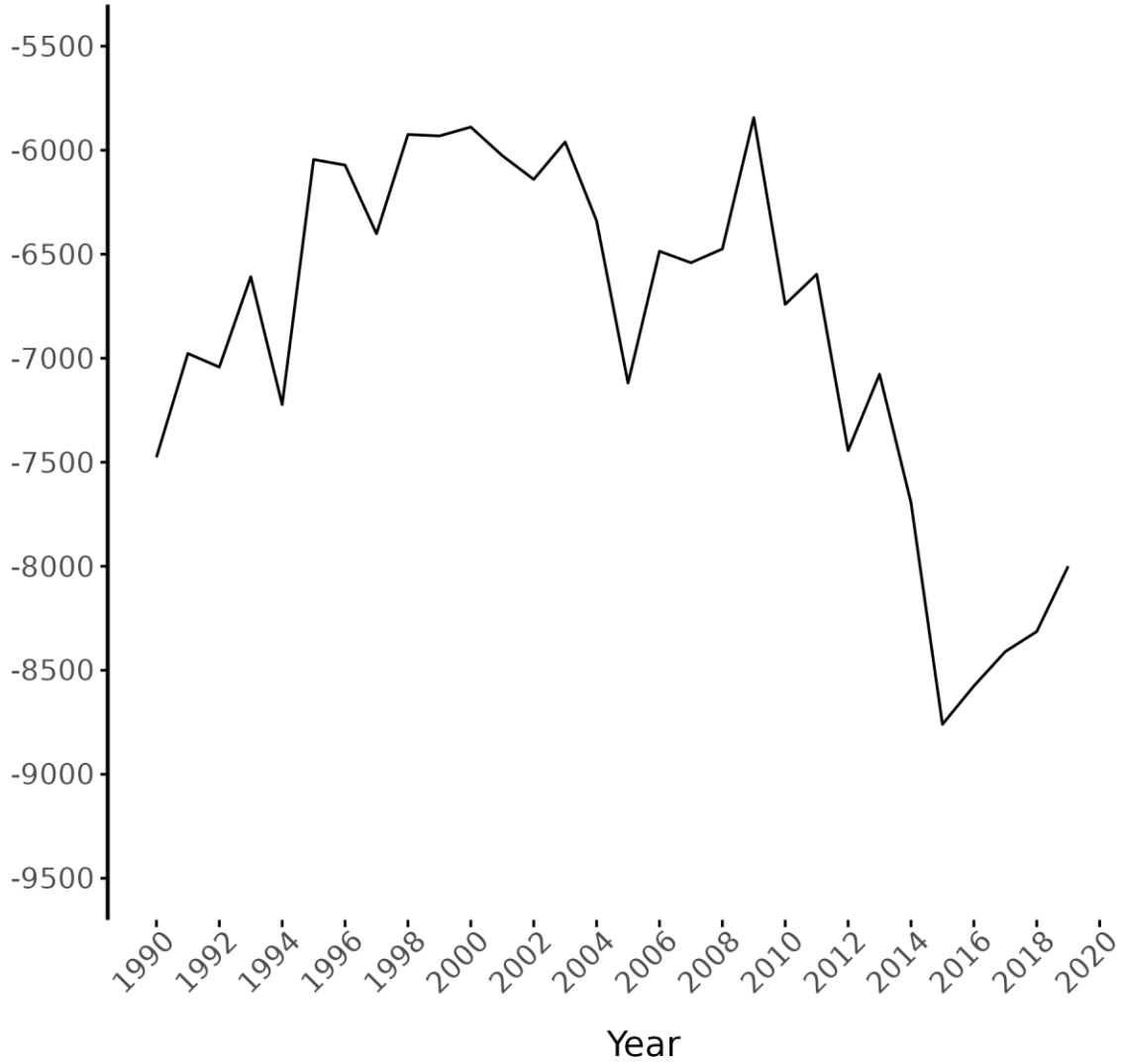
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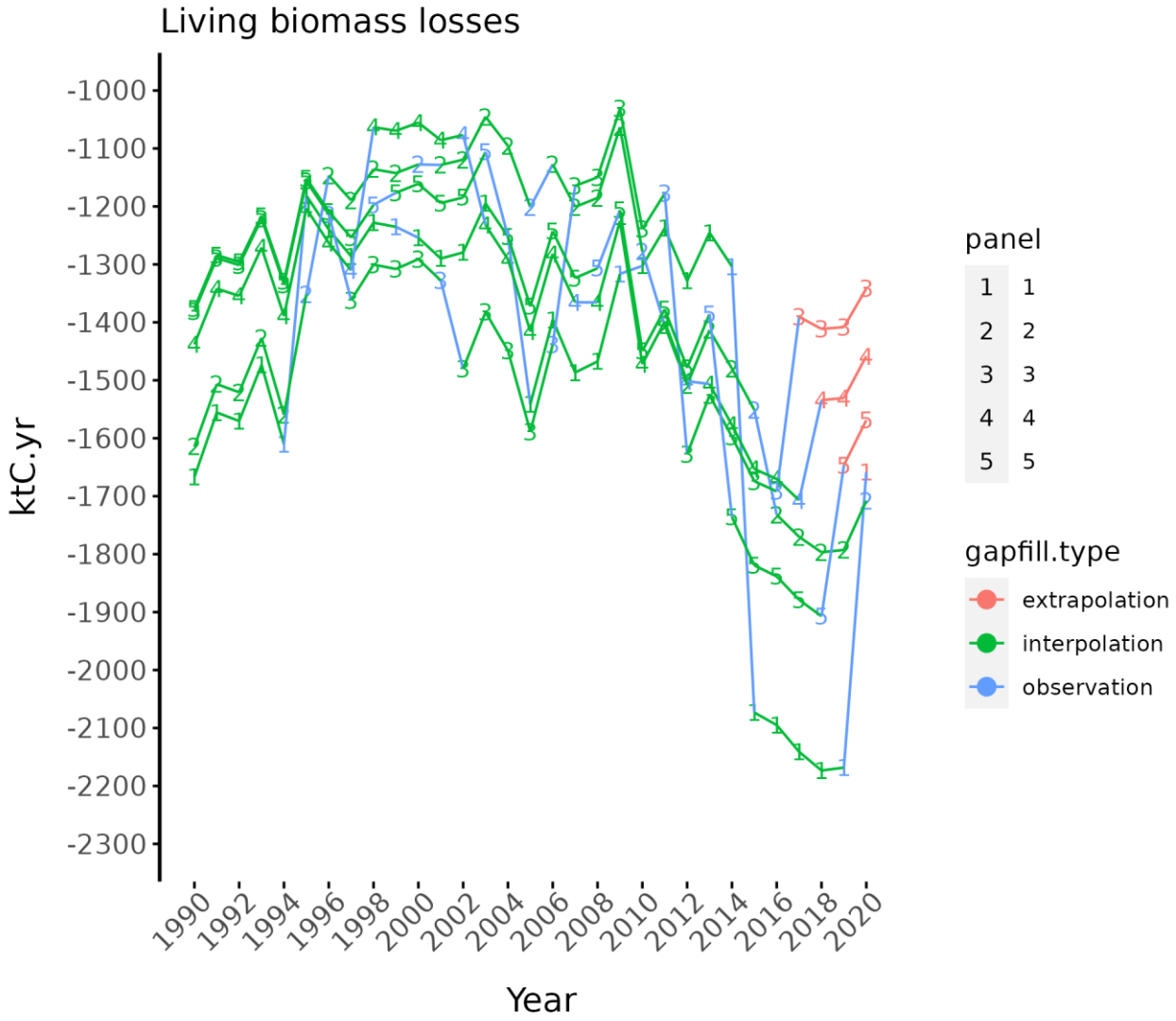
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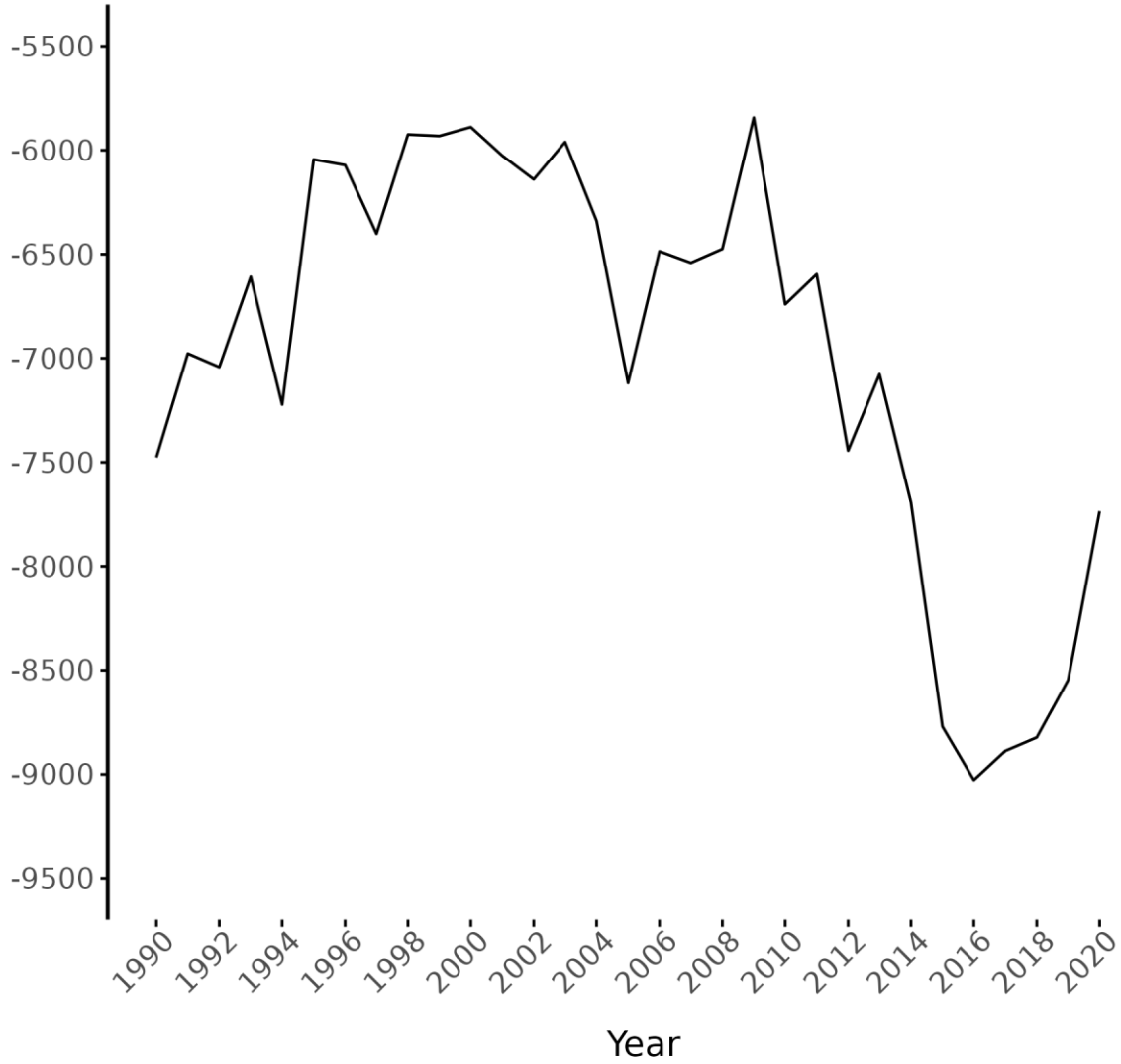
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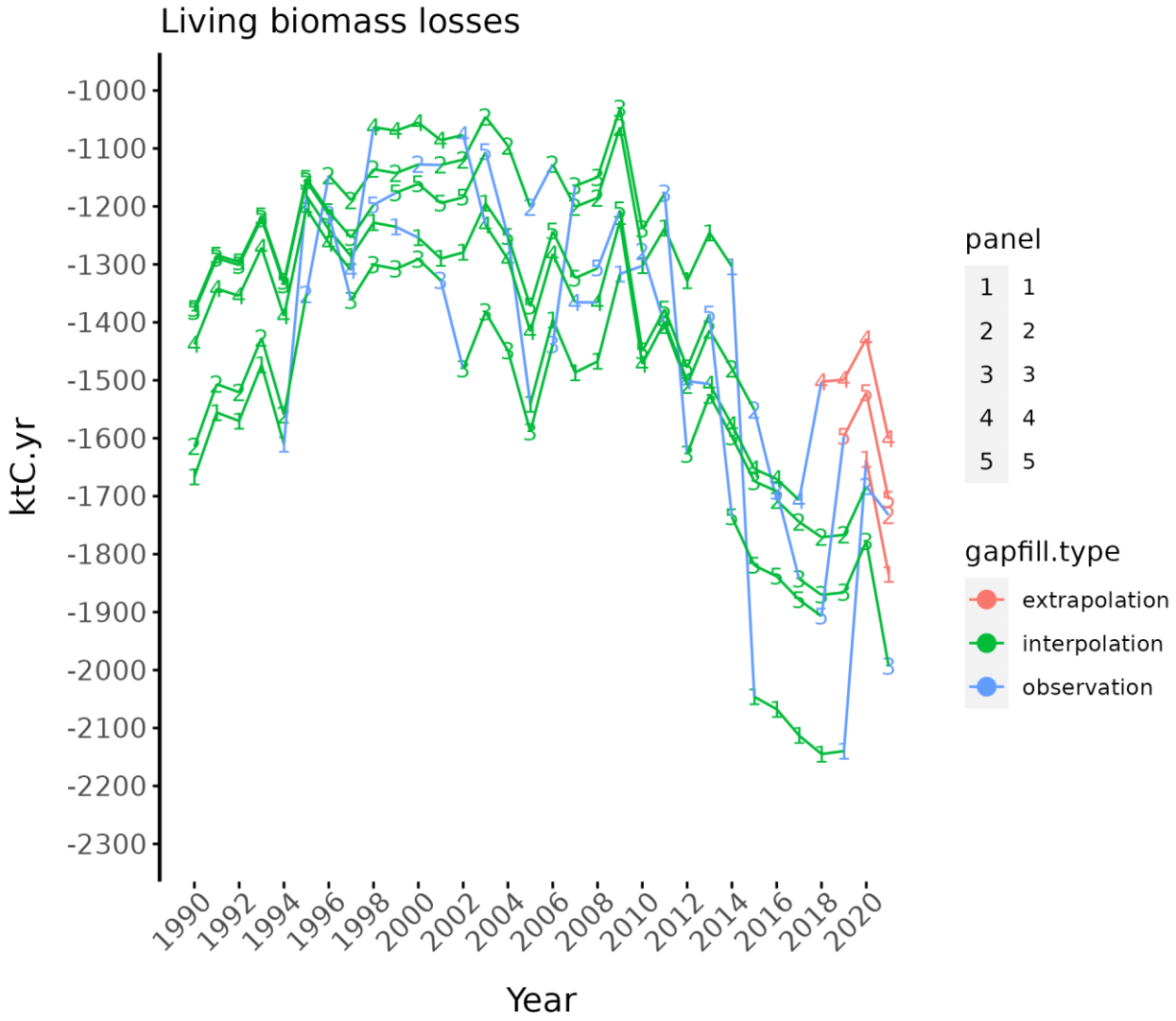
Living biomass losses
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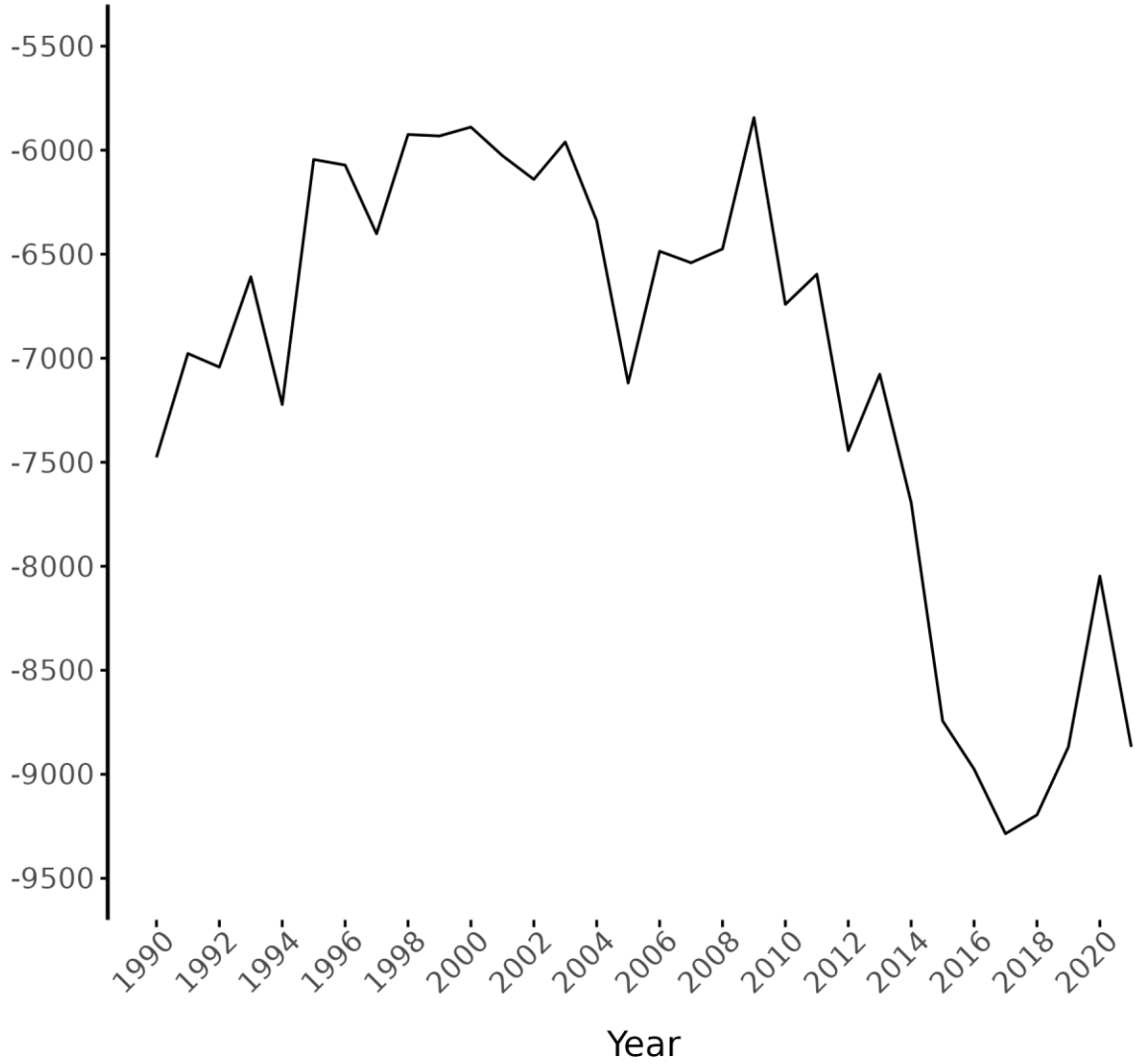
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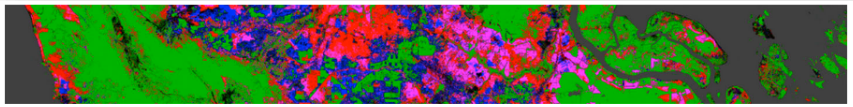
Global Forest Change (GFC) for extrapolation gap filling



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DEPARTMENT OF GEOGRAPHICAL SCIENCES

Global Forest Change 2000-2022 Data Download

Results from time-series analysis of Landsat images in characterizing global forest extent and change from 2000 through 2022. For additional information about these results, please see the associated journal article (Hansen et al., *Science* 2013).

Web-based visualizations of these results are also available at our main site:

https://glad.earthengine.app/view/global-forest-change

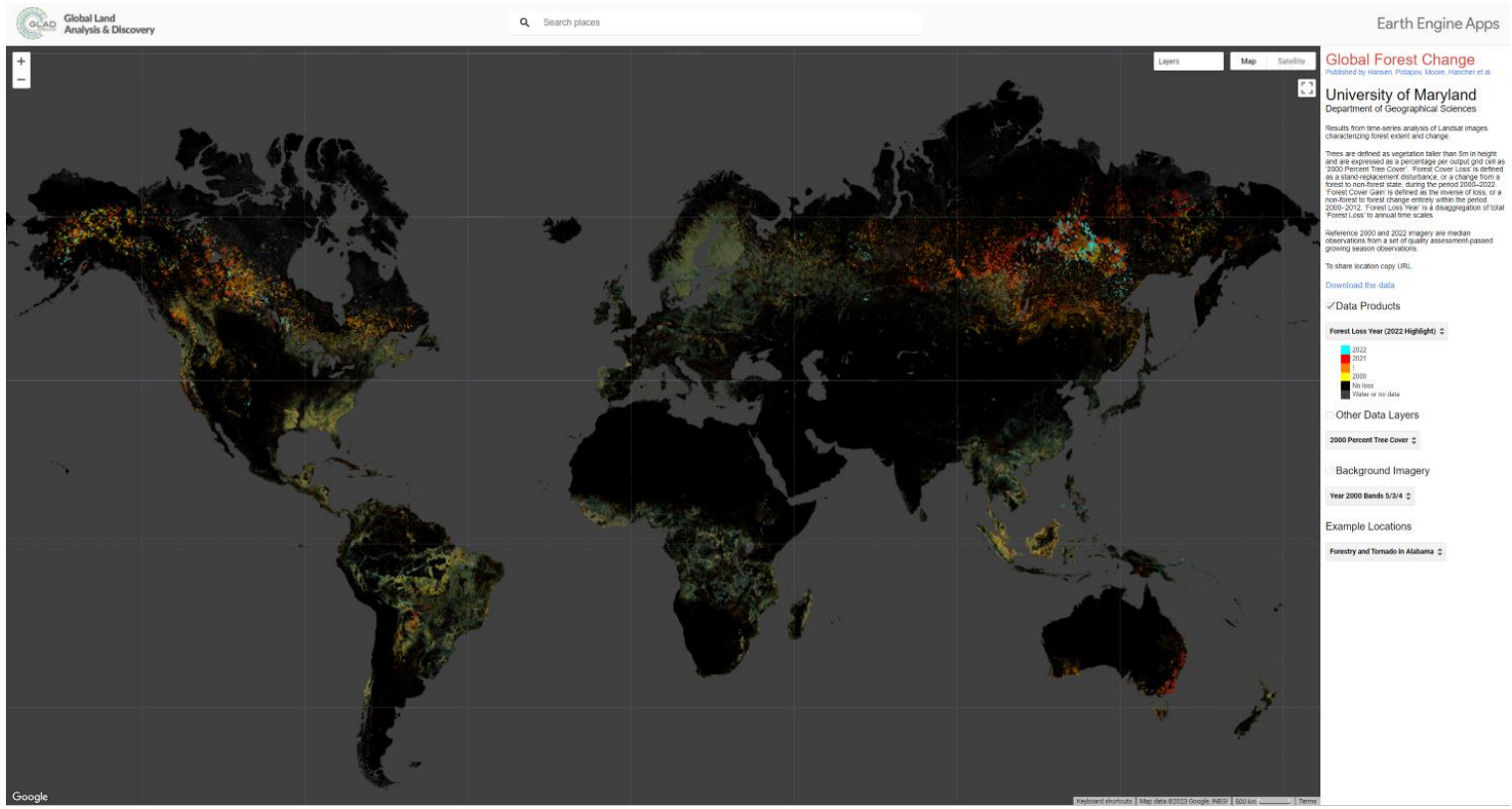
Please use that URL when linking to this dataset.

We anticipate releasing updated versions of this dataset. To keep up to date with the latest updates, and to help us better understand how these data are used, please **register as a user**. Thanks!

Usage Notes

The Global Land Analysis and Discovery (GLAD) laboratory at the University of Maryland, in partnership with Global Forest Watch (GFW), provides annually updated global-scale forest loss data, derived using Landsat time-series imagery. These data, available here, are a relative indicator of spatiotemporal trends in forest loss dynamics globally. However, inconsistencies exist due to the following factors:

1. Differences in Landsat sensor technology, whether Thematic Mapper, Enhanced Thematic Mapper Plus, or Operational Land Image data. For example, the Operational Land Imager (2013-onward) onboard the Landsat 8 spacecraft employs a pushbroom sensor technology that increases per observation dwell time compared to past whiskbroom systems. The result is a signal to noise ratio that is a magnitude greater than that of Landsat 7's Enhanced Thematic Mapper Plus sensor. The increased signal enables better detection capabilities in mapping land change.
2. Data richness, or the number of viable land observations available as inputs to analysis. The global acquisition strategy has improved over time, with acquisitions increasing from under 150k per year in the early 2000s to over 250k per year in recent years. Additionally, Landsat 7 was the only input for the 2001-2012 initial product, and is affected by the scan-line corrector malfunction of the Enhanced Thematic Mapper from 2002 onward, where nearly a quarter of the footprint of each scene is not collected. Also, the gap between the decommissioning of Landsat 5 in 2011 and the launch of Landsat 8 in 2013 resulted in a total 2012 global collection of less than 100k Landsat 7 images.
3. Algorithm adjustments, including modifications of training data and input image feature space. For example, the original 2001-2012 forest loss map was made using a single algorithm run, compared to subsequent years that have been added individually. Additionally, models have been iterated to improve performance in the 2012-forward period. Such changes in the mapping method can result in year to year inconsistencies.



NIBIO

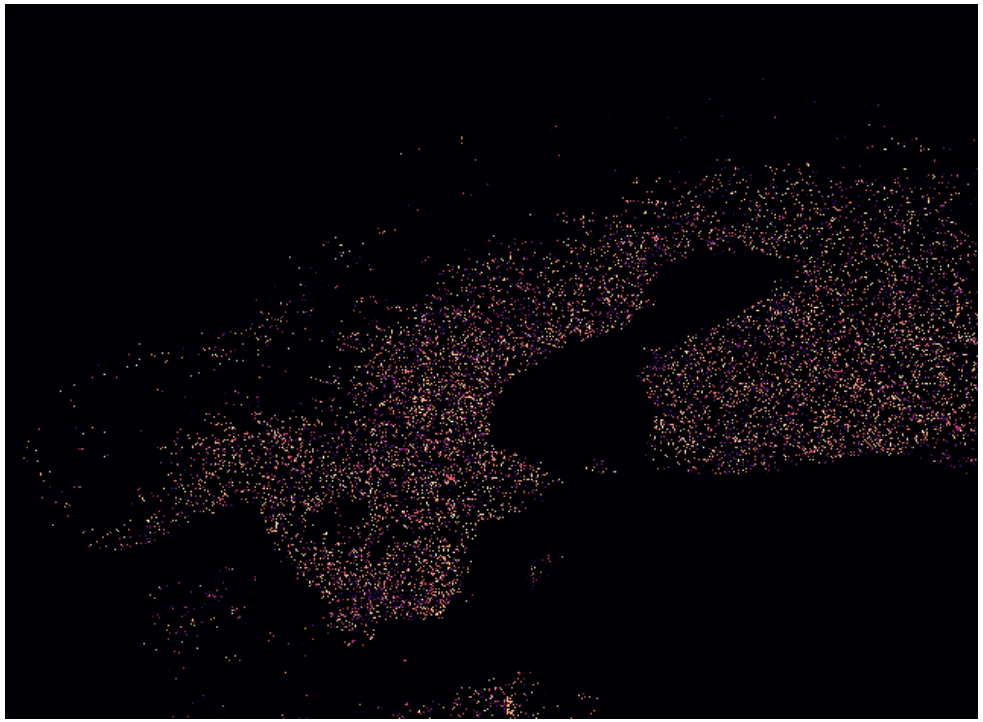
GFC extrapolation for clear cut harvest

Interpolation

Year	PANEL_1	PANEL_2	PANEL_3	PANEL_4	PANEL_5
1986-1993	1	1	1	1	1
1994	2				
1995		2			
1996			2		
1997				2	
1998					2
1999	3				
2000		3			
2001			3		
2002				3	
2003					3
2004	4				
2005		4			
2006			4		
2007				4	
2008					4
2009	5				
2010		5			
2011			5		
2012				5	
2013					5
2014	6				
2015		6			
2016			6		
2017				6	
2018				GFC	6
2019	7			GFC	GFC
2020	GFC	7		GFC	GFC
2021	GFC	GFC	7	GFC	GFC

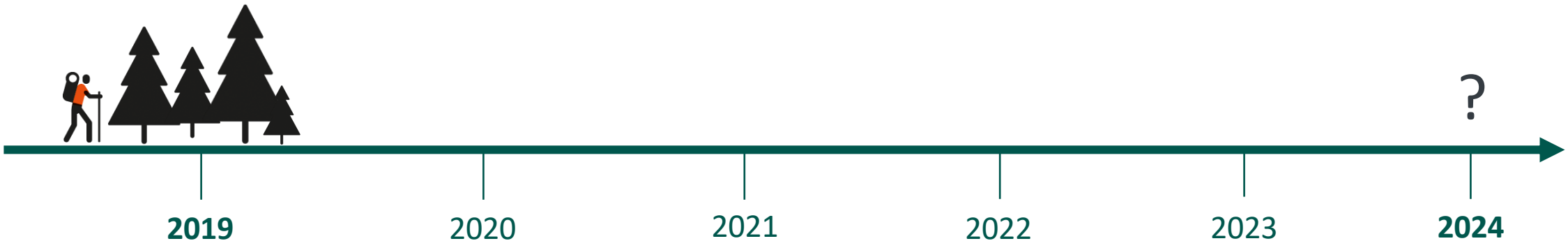
Supplementary data:

- Use Global Forest Change dataset as an overlay map to determine if an NFI plot has been harvested, and then estimate the biomass loss for the plot.

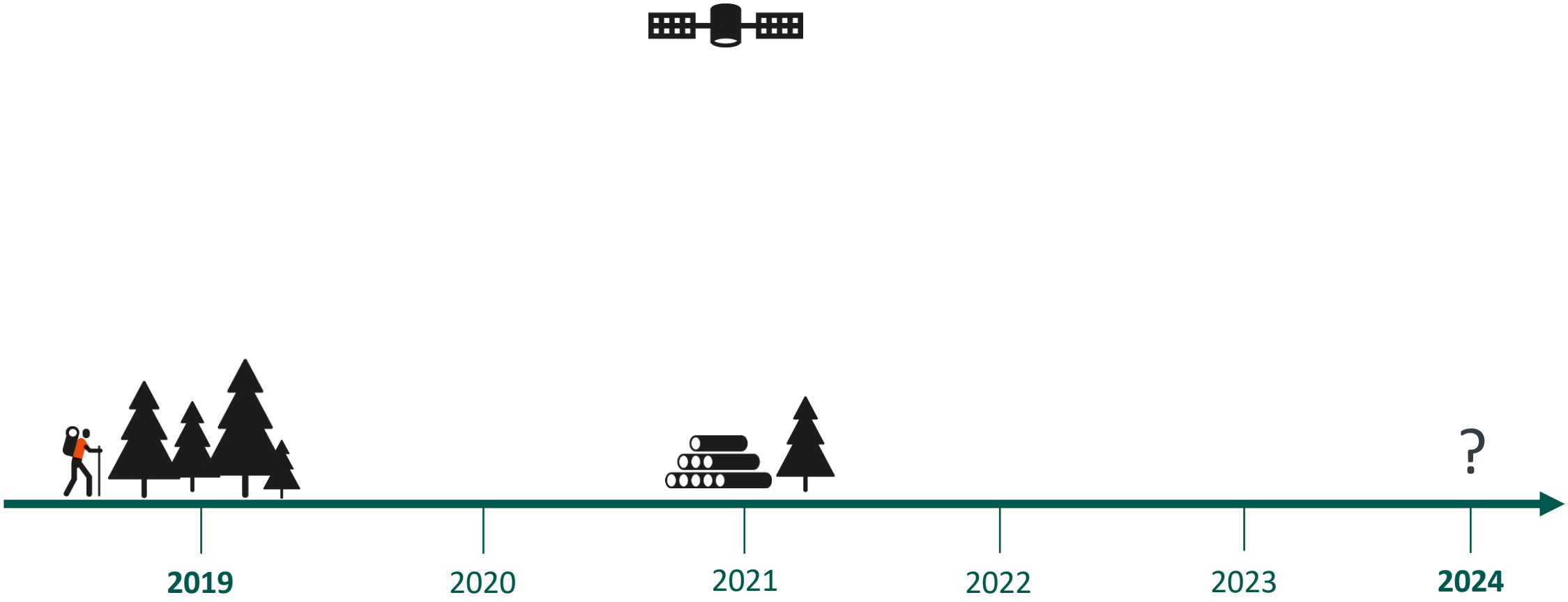


NIBIO

Predicting harvest loss concept

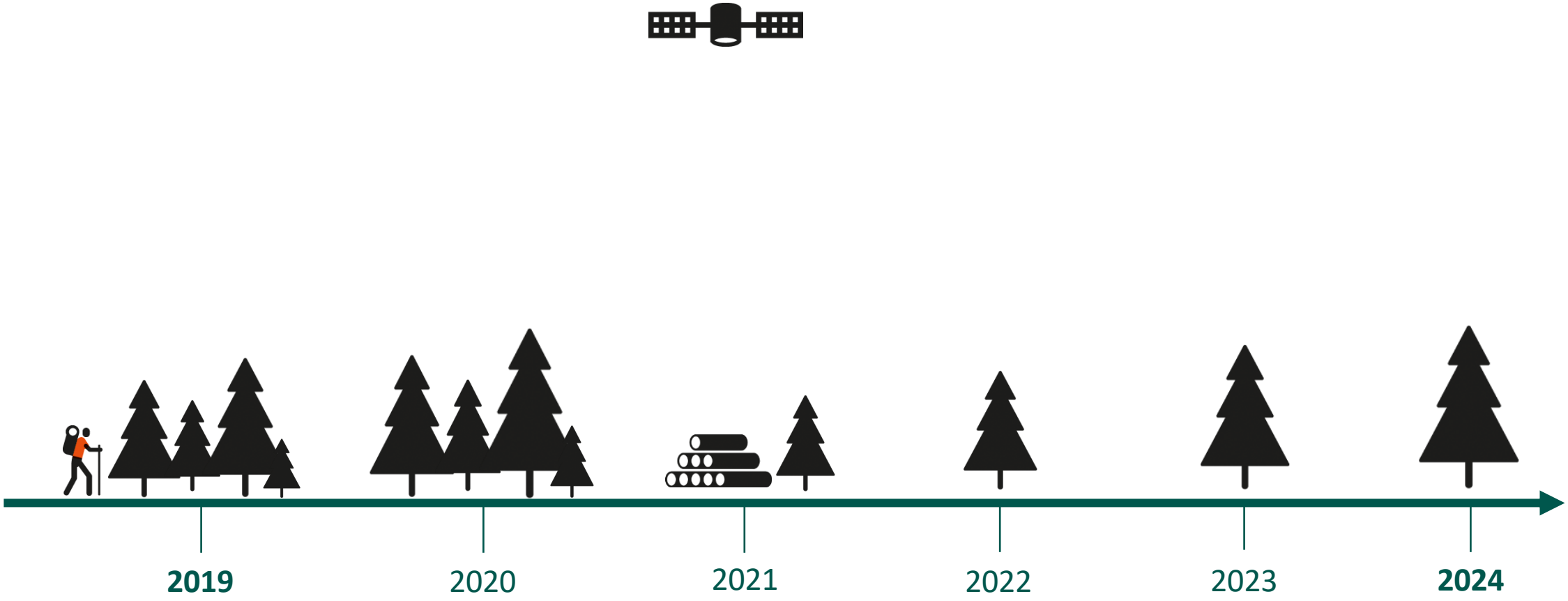


Predicting harvest loss concept



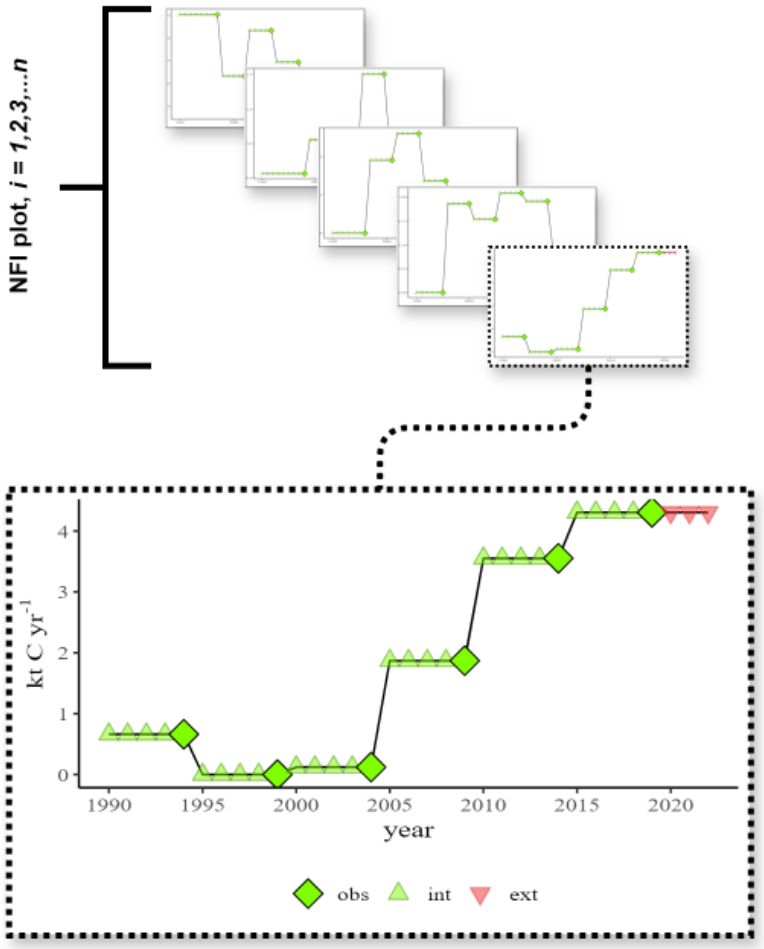
Predicting harvest loss concept

- Loss % based on NFI stats for harvest
- Growth (gains) based on last observation

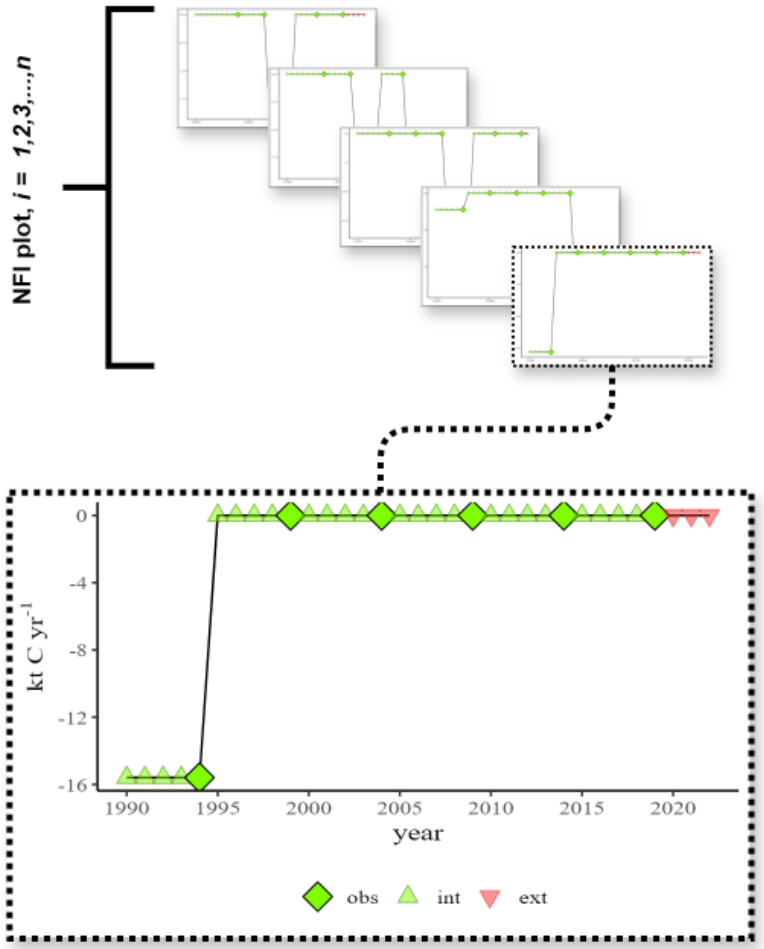


Step 1: interpolation and extrapolation

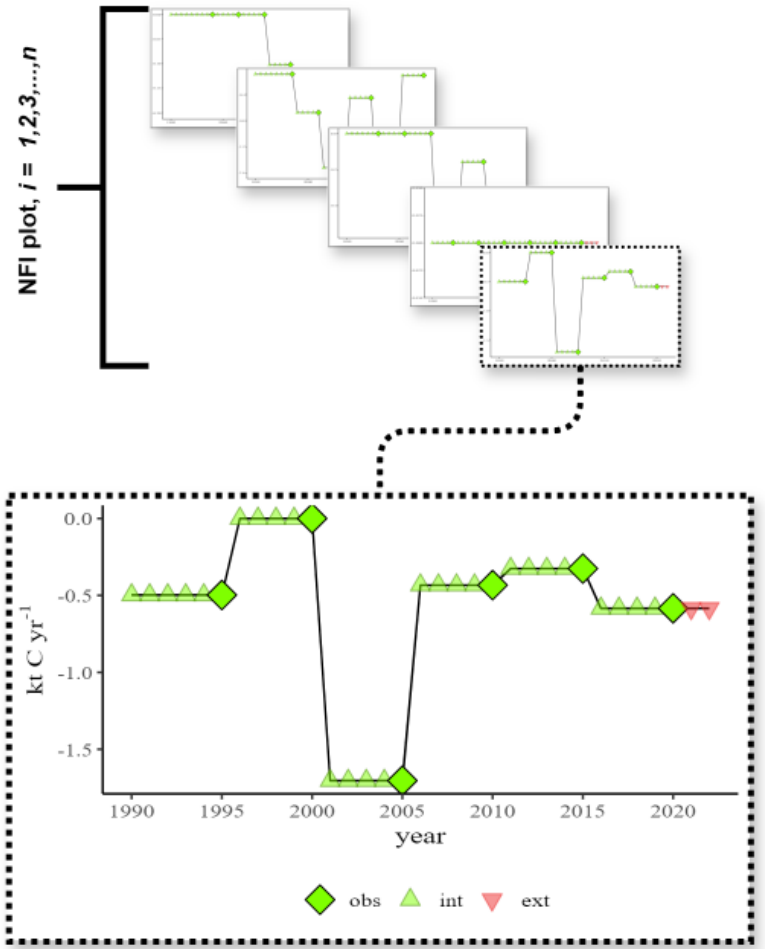
Gains



Clearcut Harvest



Other Losses



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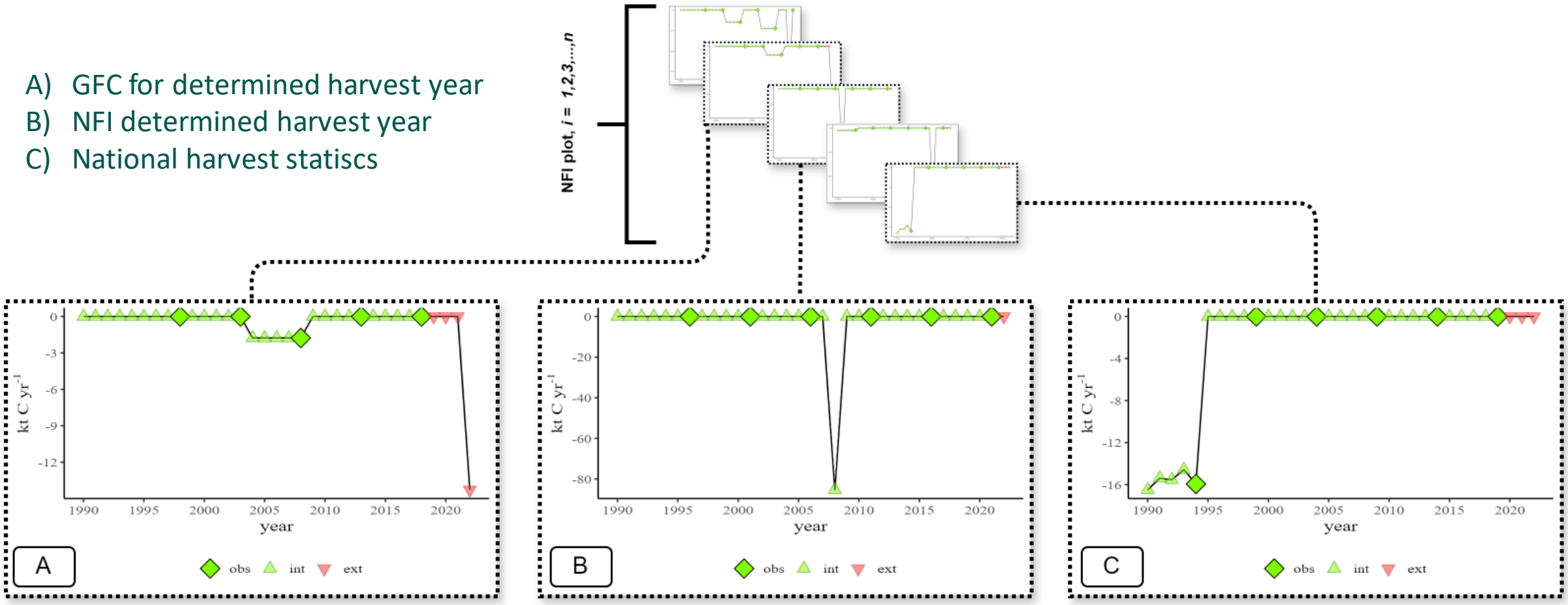
Step 2: redistribution to harvest year

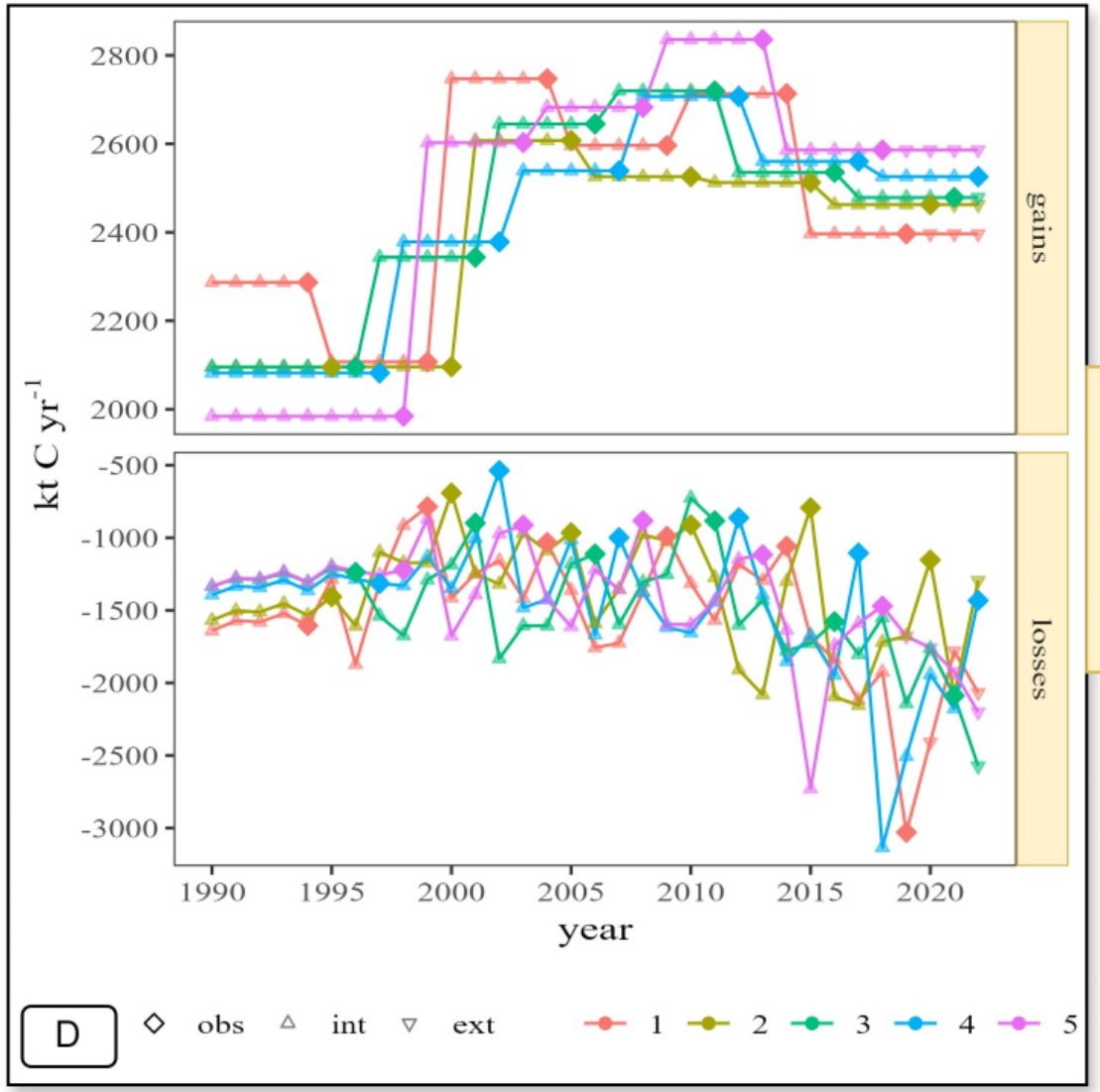
Clearcut Harvest

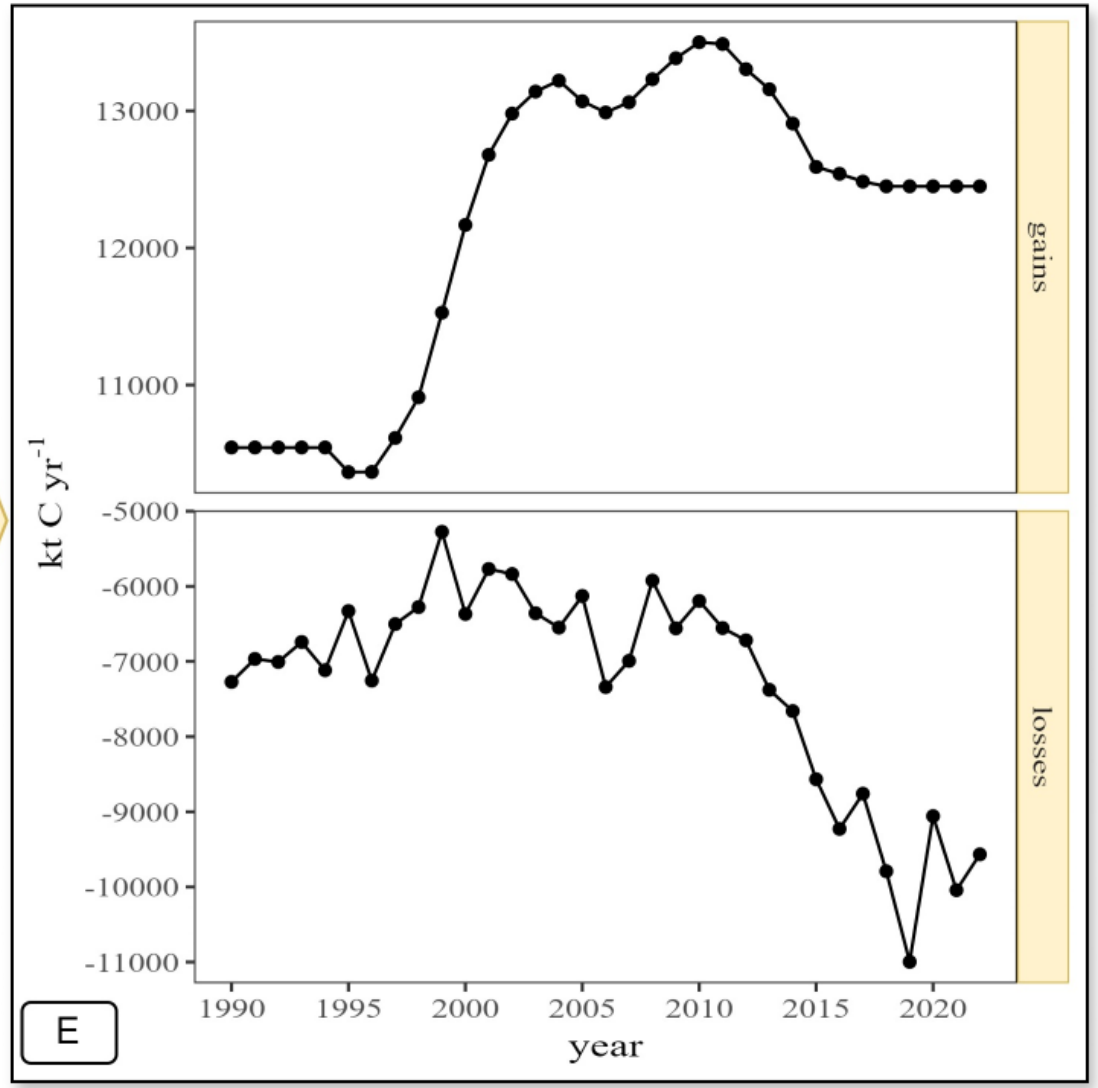
A) GFC for determined harvest year
B) NFI determined harvest year
C) National harvest statiscs



NIBIO

Step 3: Aggregation





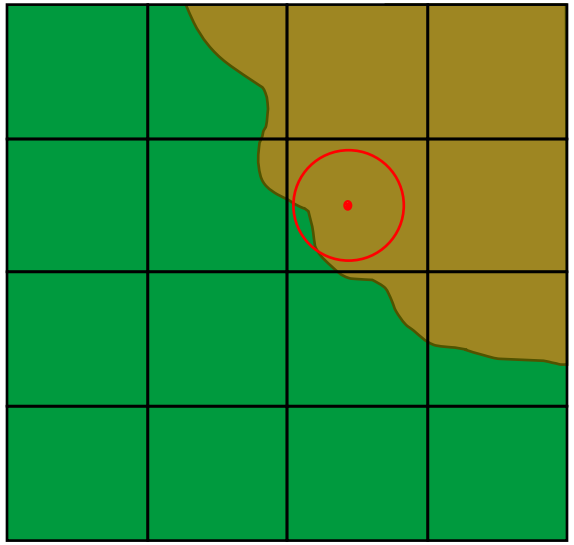
D) National aggregation per panel

E) National aggregation

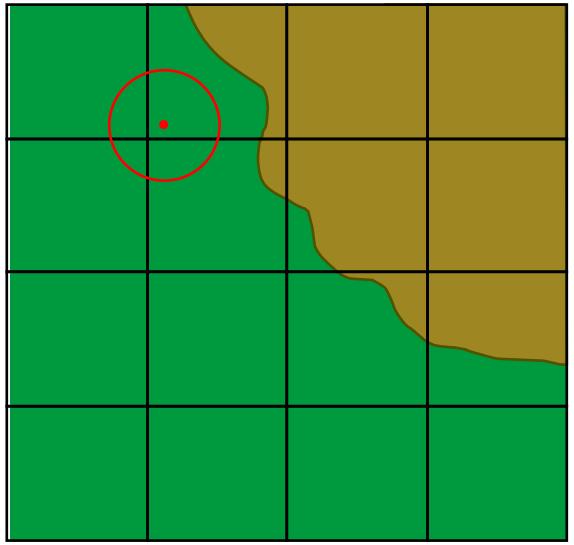
NIBIO

GFC QC: manual spatial check of harvest

Scenario 1

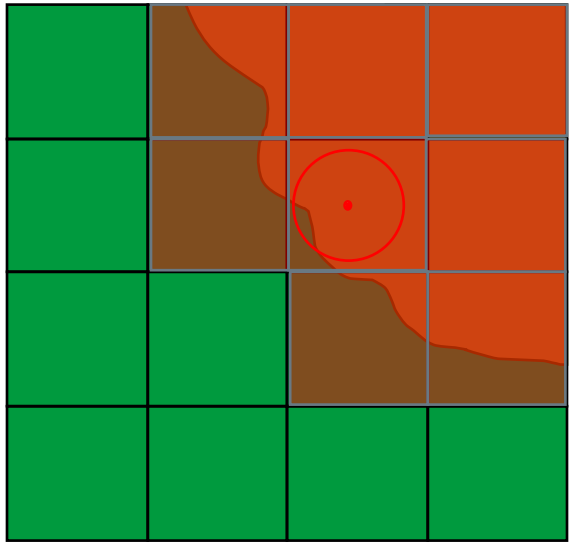


Scenario 2

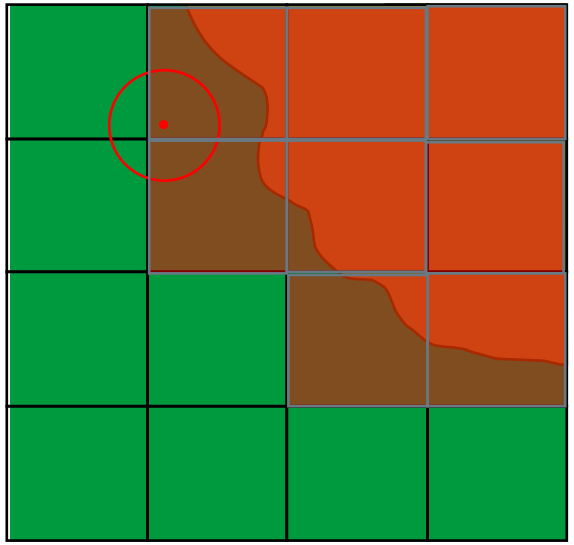


GFC QC: manual spatial check of harvest

True Positive



False Positive

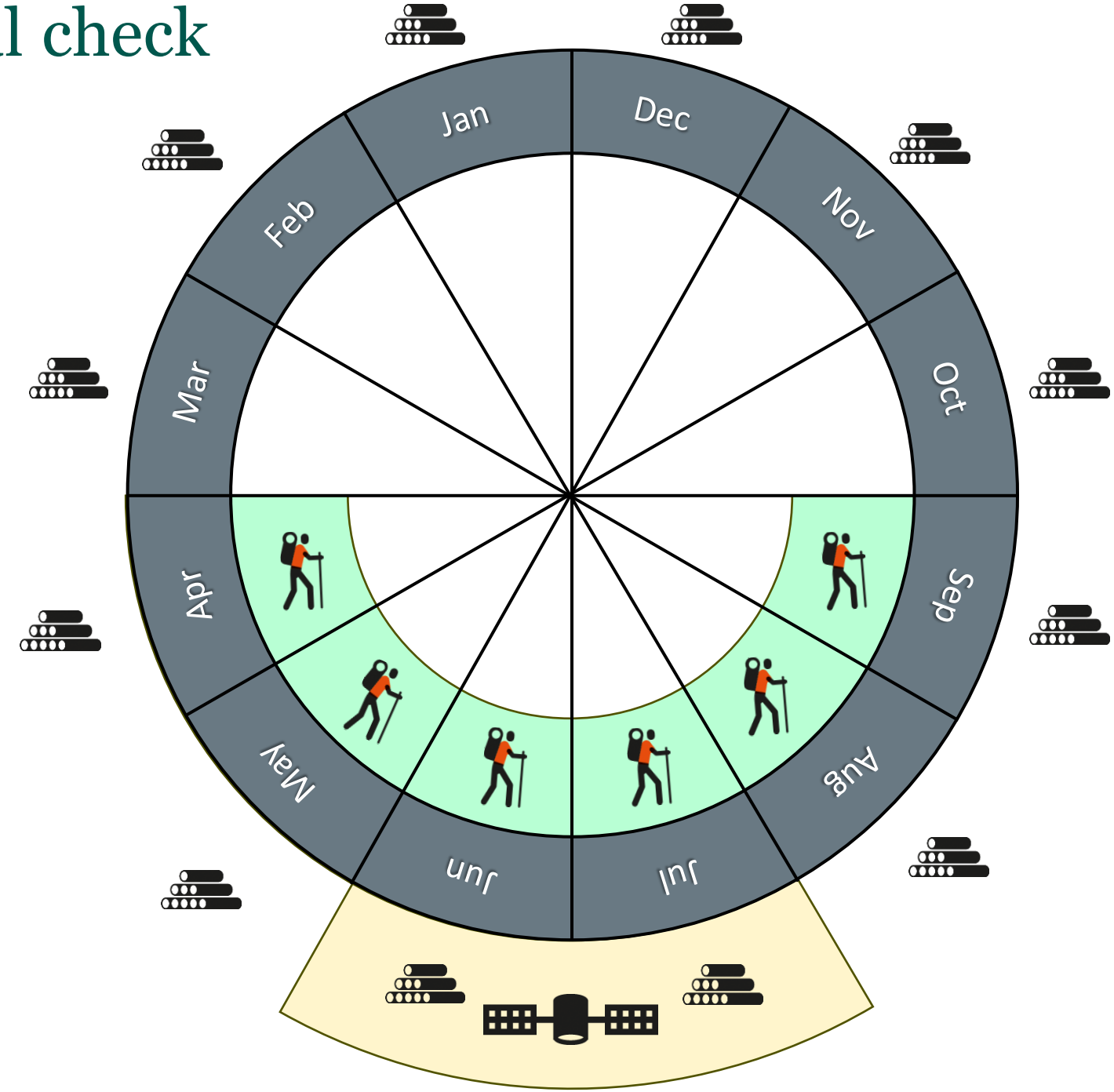


Commission test: *23% false possitve*

Omission test: *26% false negative*

GFC QC: temporal check

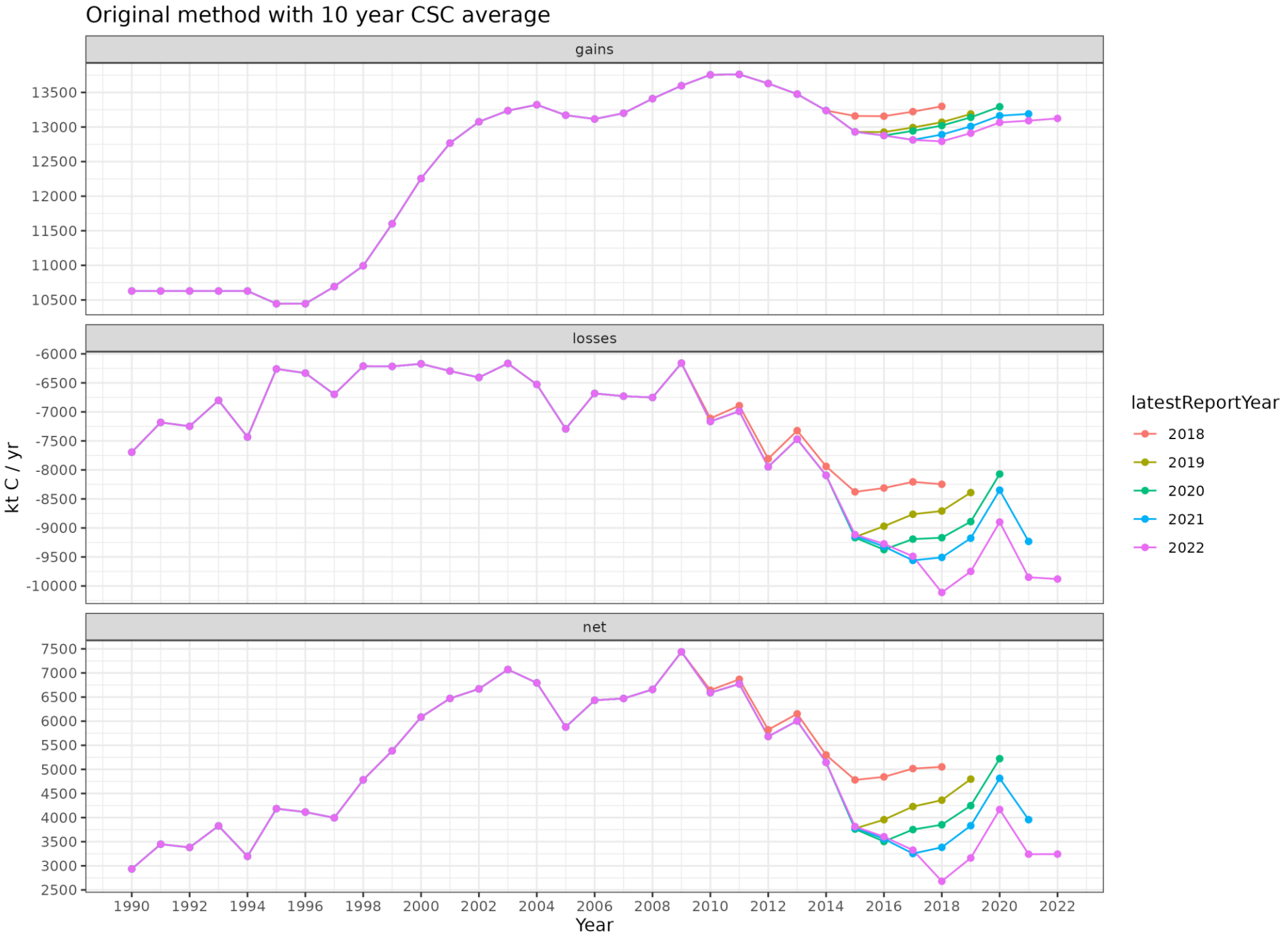
Event & obs order			Year
harv	GFC	NFI	✓✓
harv	NFI	GFC	✓✓
GFC	harv	NFI	(✓)
NFI	harv	GFC	(✓)
GFC	NFI	harv	+1
NFI	GFC	harv	+1



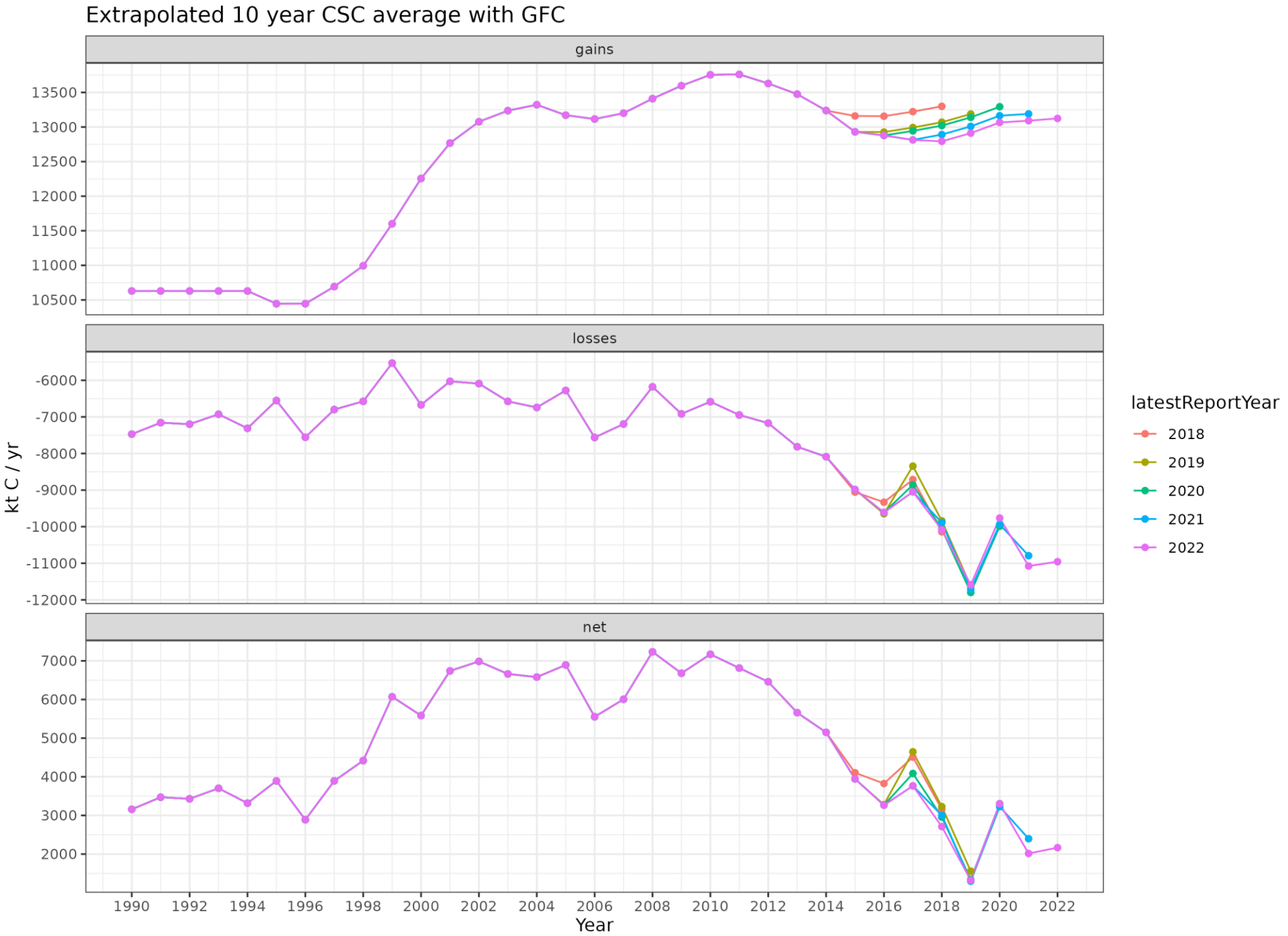
NIBIO

Recalc. verification

NIR2023 method

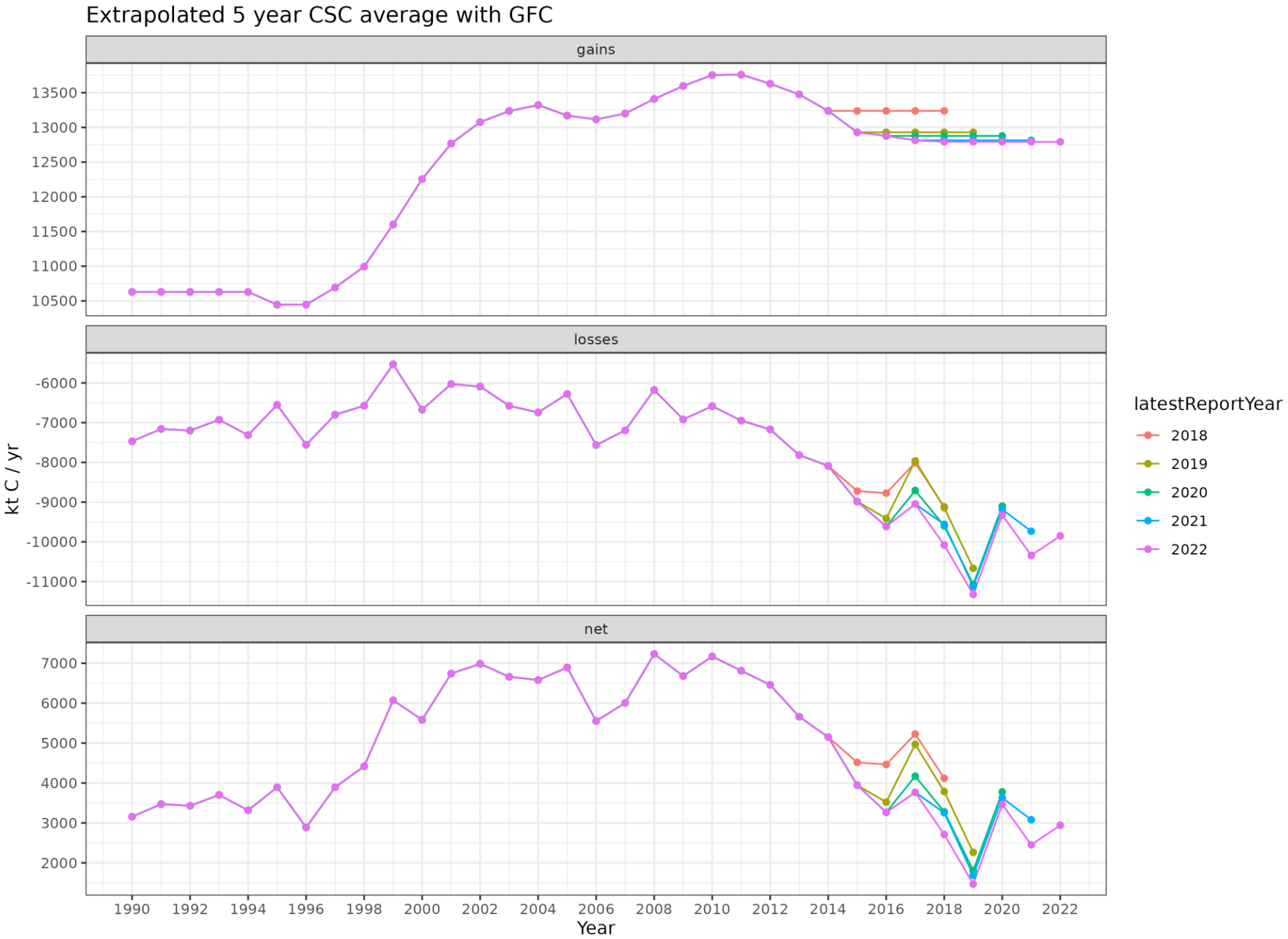


Recalc. verification



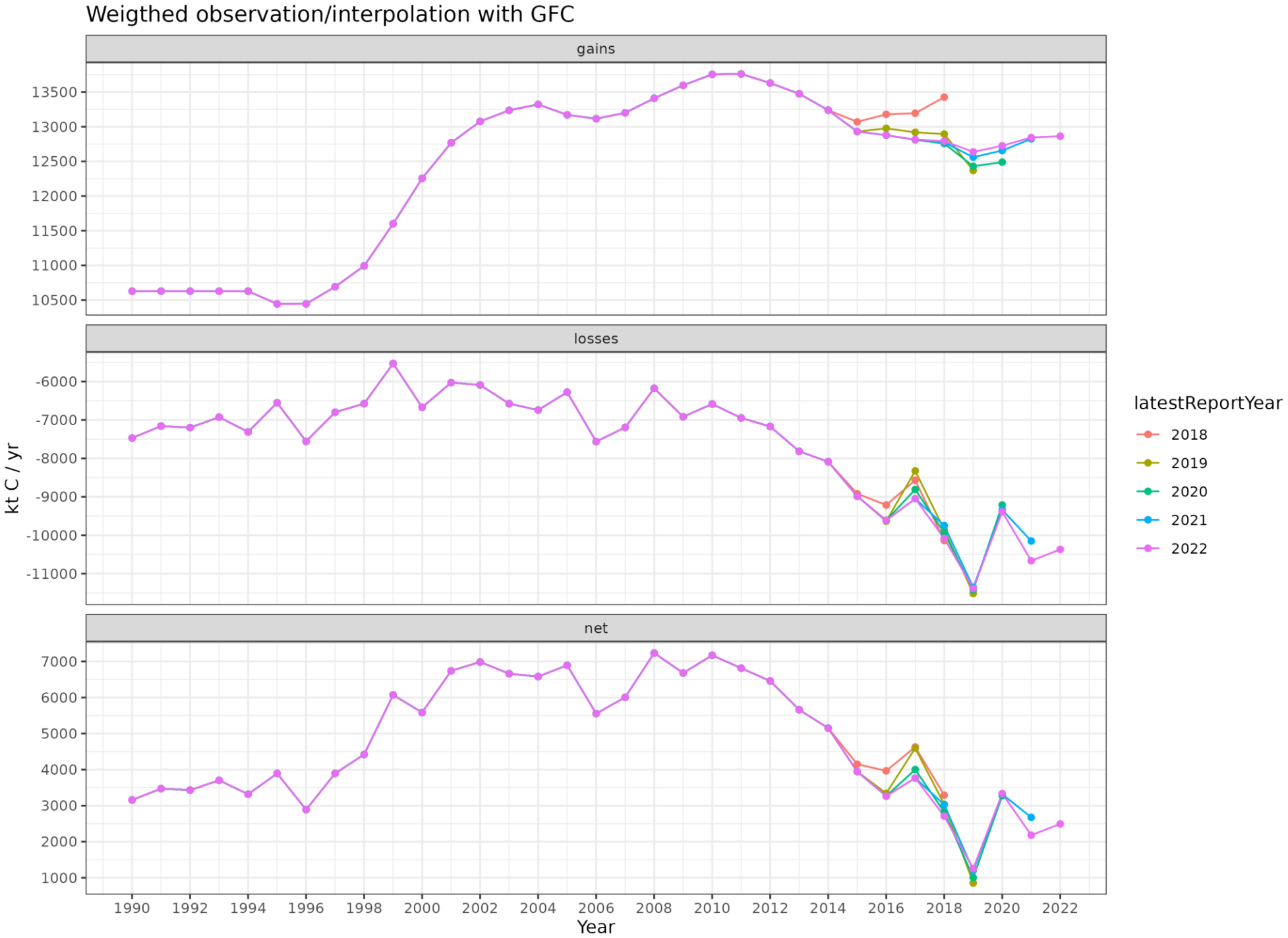
Recalc. verification

NIR2024 method

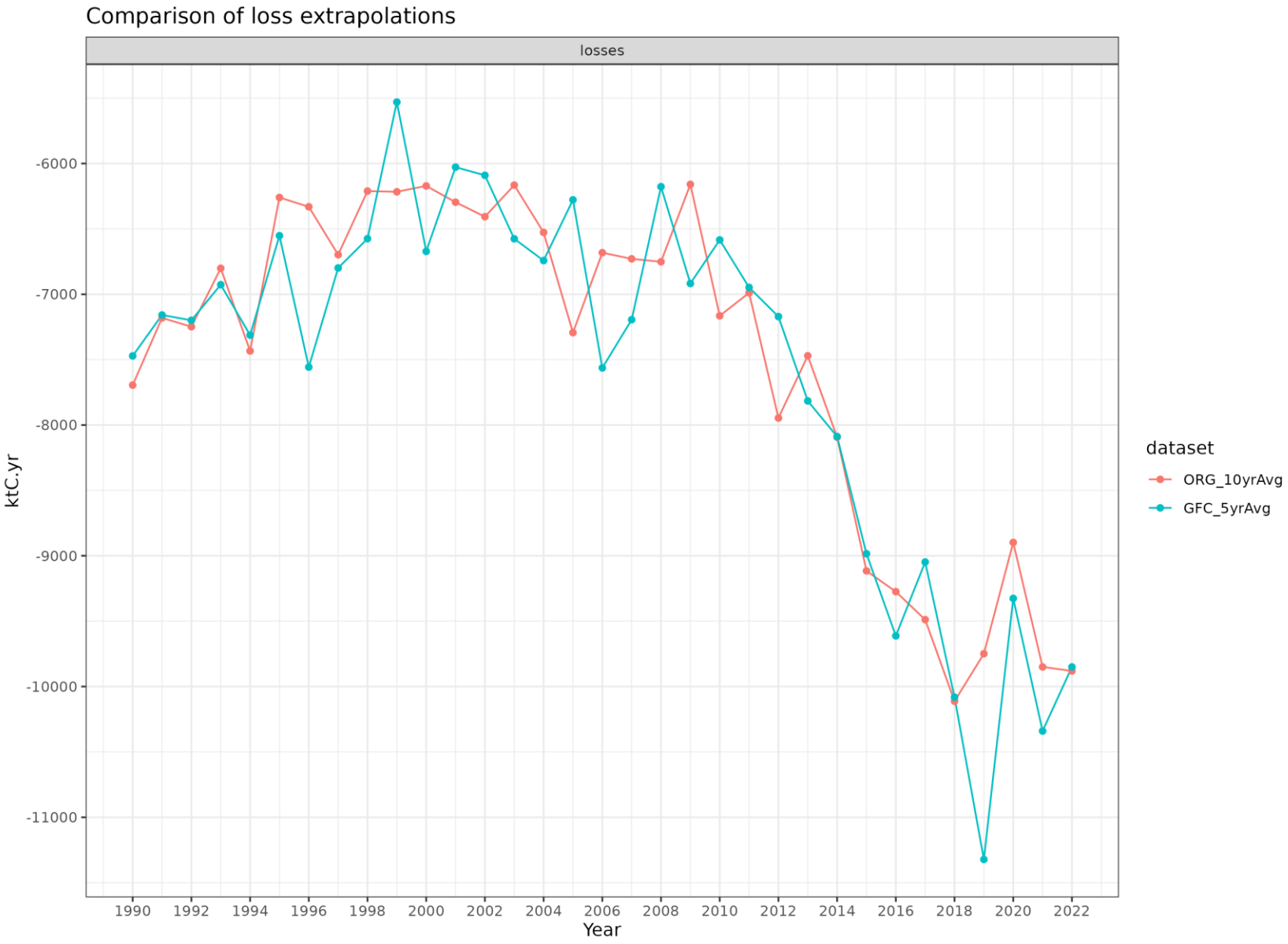


Recalc. verification

perhaps future method?



Summary



Old losses method (ORG):

- Extrapolate average loss for last 10 years (last two NFI cycles)
- Use national harvest statistics as weights to redistribute all losses to harvest year for whole time series.

New losses method:

- Use GFC to determine the loss due to clear cut harvest for each forest plot.
- Extrapolate average loss from natural mortality, thinning, and other harvest from last 5 years (last NFI cycle) for each plot.
- Use NFI harvest year and GFC to redistribute losses from clear cut harvest for timeseries (only years >1998).
- Use national harvest statistics as weights to redistribute losses related to comm. harvest for the first two NFI cycles (only years ≤1998)

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Thank You!

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