

Large-scale detection and monitoring of red cast outbreaks

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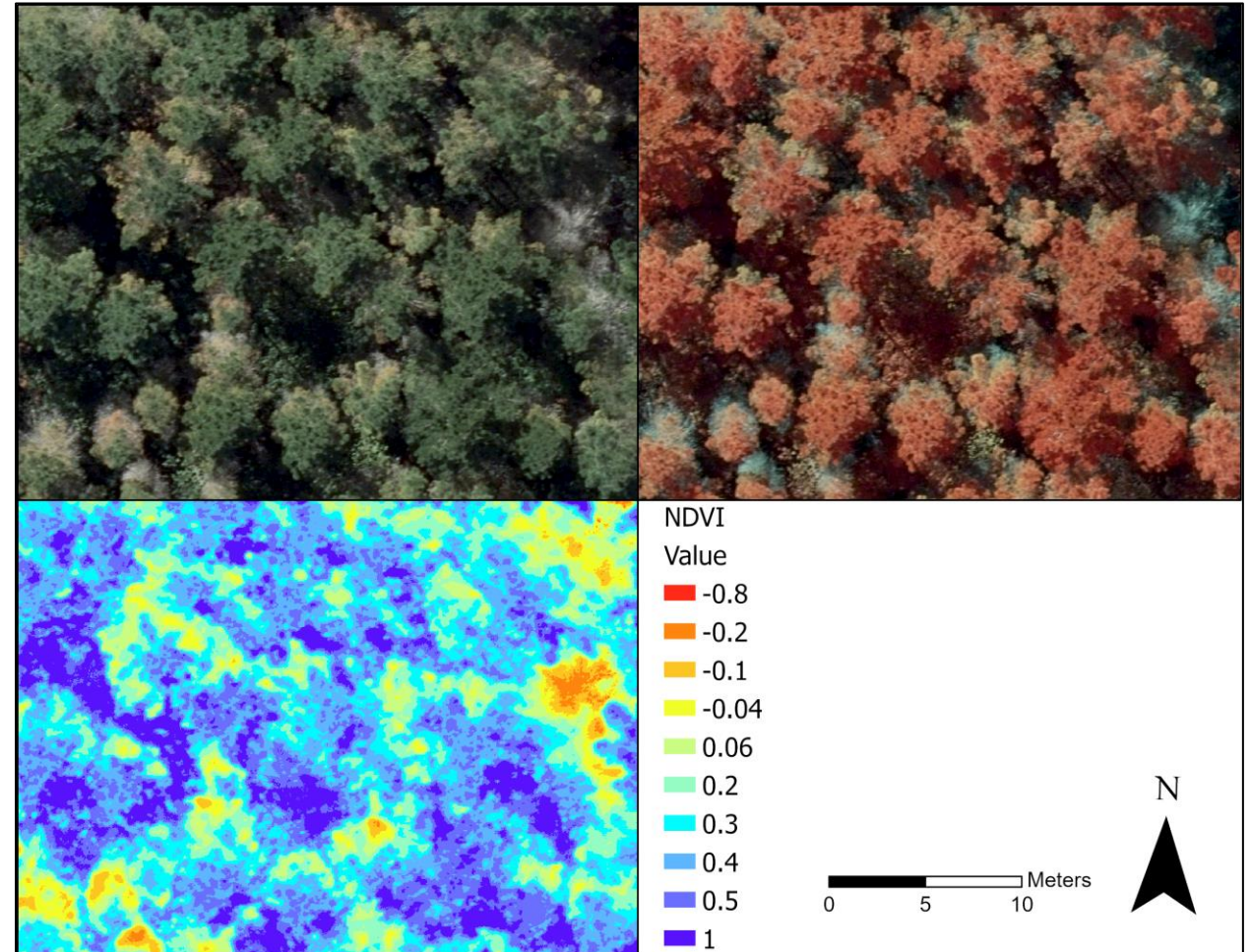


Purpose of presentation

- Explain how this work relates to other topics in Resilient Forests.
- Where we are at
 - The detection process and RNC monitoring app developed by Indufor
- Future plans and TST support

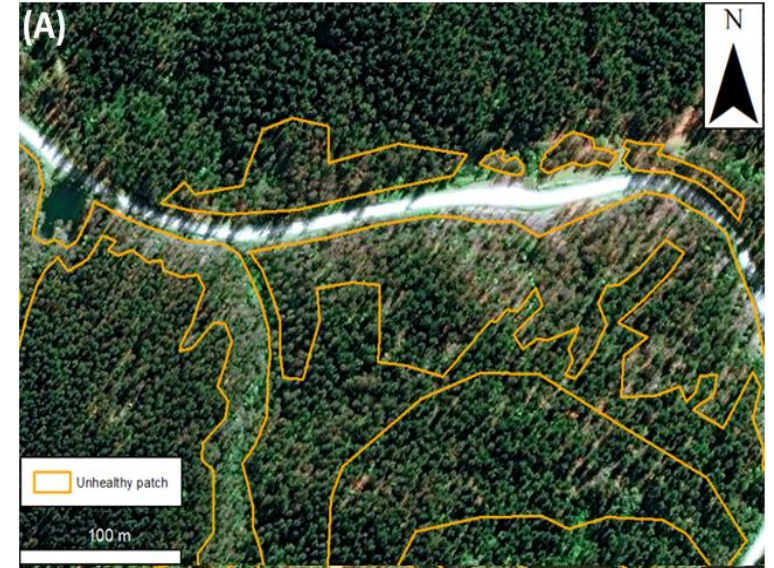
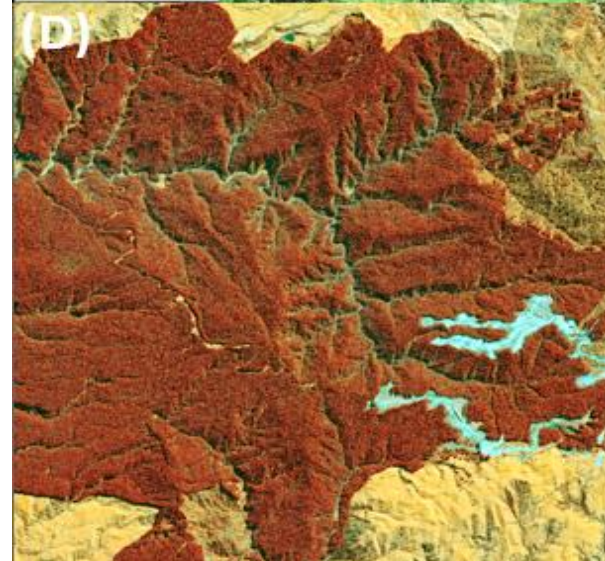
Introduction & Background: Remote Sensing

- Monitoring
 - Reports
 - Forest Health Database
 - Nearly all roadside observations
- In parallel: Copper exclusion trial
- Aerial imagery + ground
 - Confirmed aerial scoring as a method
 - Operational use for 3 years now



Introduction & Background: Remote Sensing

- Why not use this more broadly?
- Virtual trial series
- Disease prone regions + surveillance
- 5 VHR satellite images / year
- Score the disease
- Feed the model



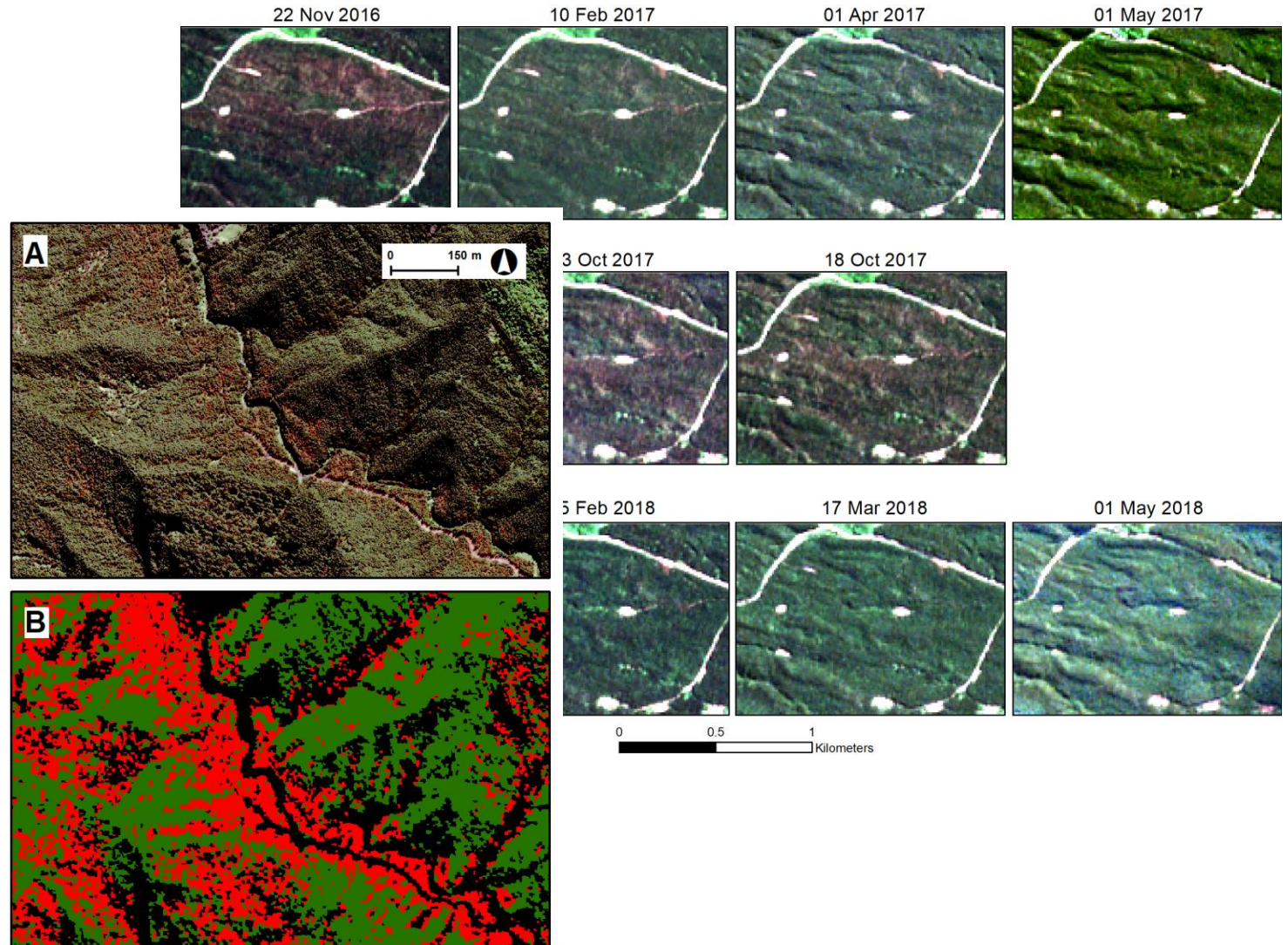
Goals: 'Tip and queue' forest health surveillance

Monitor the whole planted forest estate for pathogen outbreaks

- Detect: Free imagery (Sentinel)
- Confirm: VHR + field visit
- Database of Observations
- Predictive models

Indufor Partnership

- Expertise in monitoring at scale
- GEE processing and app building



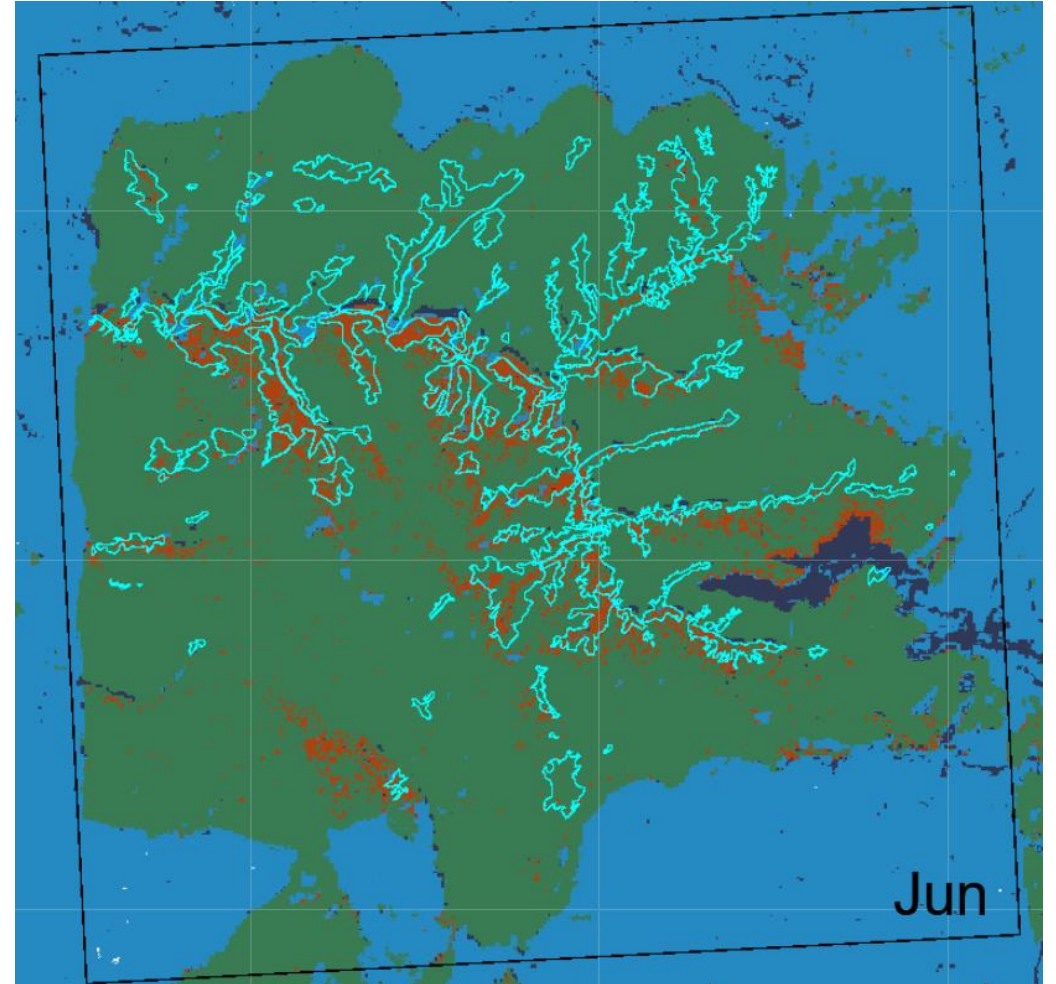
Findings

- Individual crown expression was visible in VHR imagery in September/October.
- In the atmospherically corrected Sentinel-2 scene, corresponding canopy discoloration was clear
- Using a single scene doesn't allow the separation of existing canopy issues from actual RNC disease expression
- To do this you need to use an image time series. This allows you to track the spread and intensity of the RNC outbreak



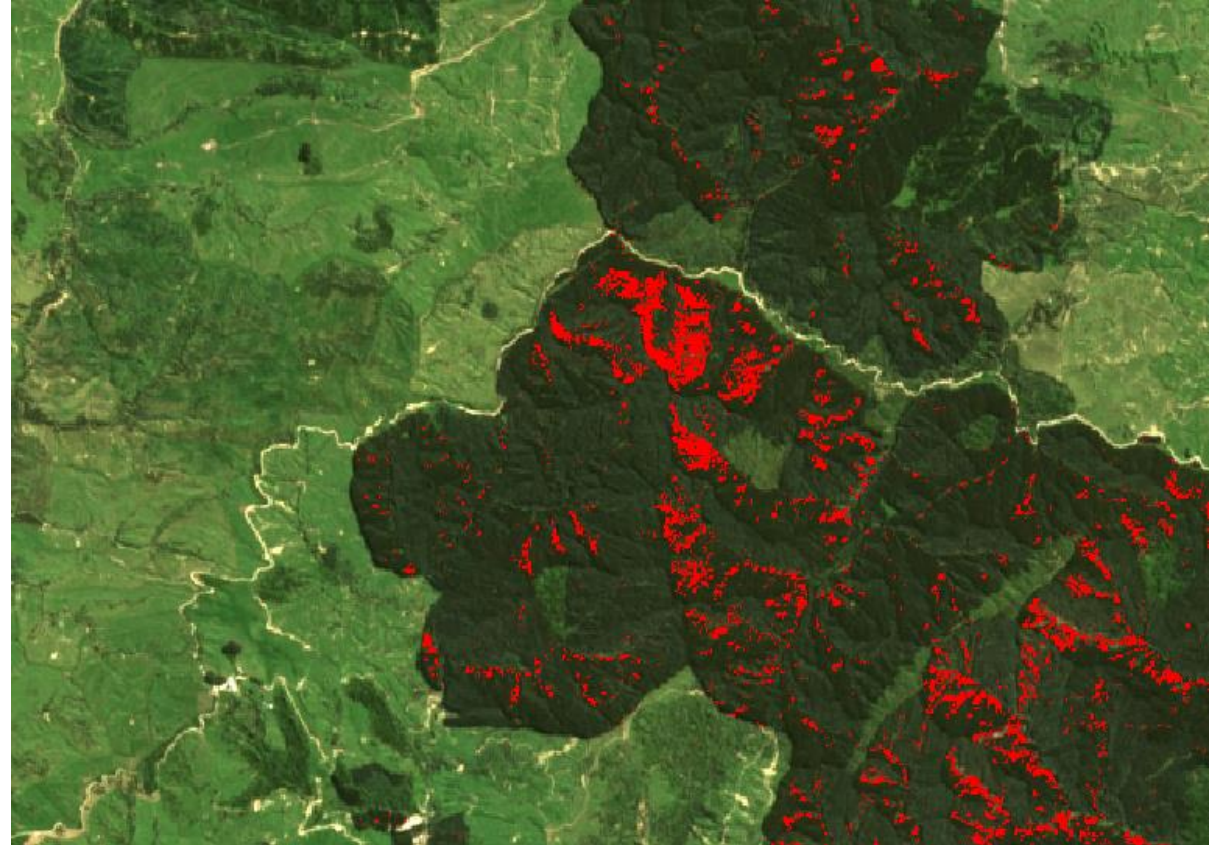
Findings

- The use of Sentinel-2 images from multiple months allows visual separation of RNC from existing canopy issues and those which don't follow a similar expression pattern
- An initial random forest classifier was trained and applied to the S2 composites
- The approach developed can successfully identify areas of RNC from the initial test datasets, with accuracy increasing as the severity of disease expression in the canopy develops over time



Annual RNC Classification

- The full model was trained using combined expression data from 2018, 2019 and 2021 over July, August and September composites, with additional training to separate likely thinning events from disease expression
- This model was then applied to corresponding 2022 imagery
- Detections for July, August and October were computed
- These were loaded into a simple web app interface to allow interactive review



Indufor Forest intelligence SCION Earth Engine Apps

Red Needle Cast Detection

Select a location to query temporal changes canopy condition.

Draw a rectangle or polygon over your area of interest to view a time series of the selected band ratio.

Click a point on the graph to load the corresponding Sentinel-2 scene as a basemap.

View example area

Rectangle Polygon

Classification Options

Select a classification: October ?

Toggle classification ?

Clip classification to East Coast admin bounds ?

Time Series Options

Start Date: 2022-03-01

End Date: 2022-11-01

2022/05/17

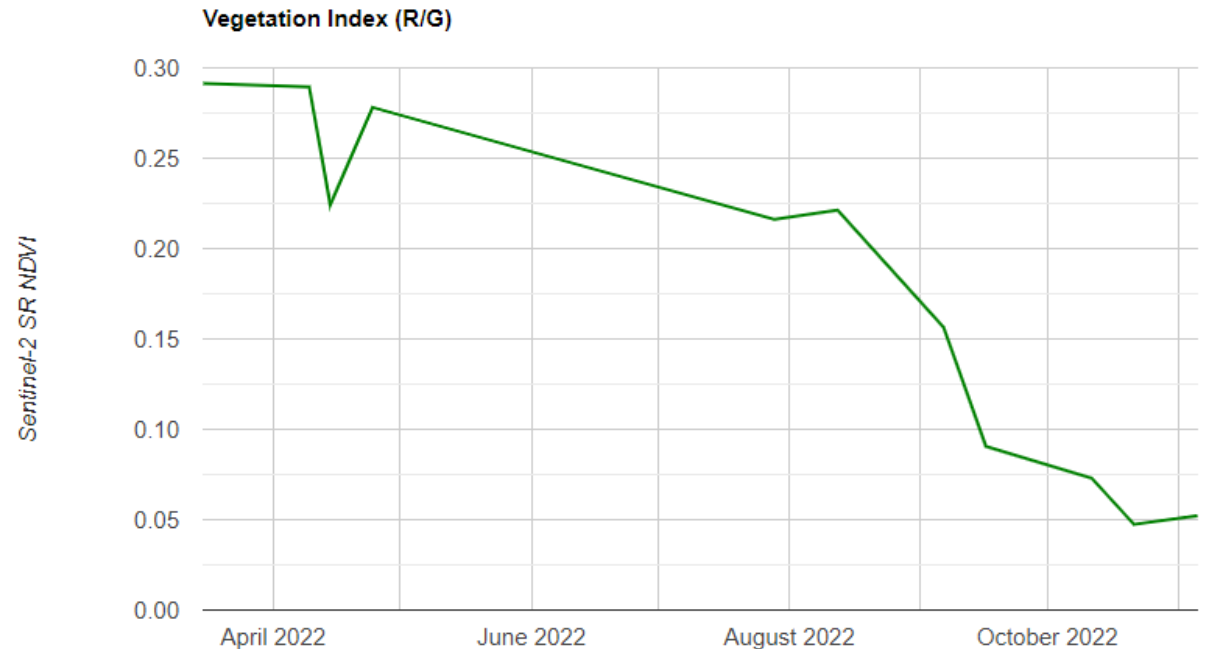
Click along the above vegetation index plot to view the corresponding Senti... RG

Date	Sentinel-2 (R/C)
April 2022	0.30
May 2022	0.25
June 2022	0.20
July 2022	0.15
August 2022	0.12
September 2022	0.10
October 2022	0.08

tinyurl.com/rncast22

Transferability of the RNC model

- We have received reports of additional RNC expression sites around NZ
- While the model is currently only being applied within the East Coast region, reviewing the Sentinel-2 time series with the same red/green index gives similar spectral patterns as the East Coast
- This example is drawn from Northland, with the first image captured in April 2022 and the expression image captured in October



Conclusions

- The discoloration of the canopy caused by RNC can be detected by Sentinel-2 sensor when expression travels into the canopy
- The initial classification model can (compared to manual digitization from high resolution satellite imagery) identify severe expression from August/September, though care must be taken to separate disease expression from other changes, like thinning
- The model improves when multiple satellite observations are available and when the discoloration of the upper crown is clear
- The approach can be applied at scale and provides a potential tool to assist with the tracking of RNC distribution and infection intensity
- The model can detect RNC outbreaks from imagery captured it hasn't been trained on, but more validation is required

Recommendations

- Send us your reports – the more confirmed expression sites we have, the more refined and generalized the model can become while also allowing robust validation
- Further develop, extend and validate the satellite-based detection framework
- Explore the inclusion of range of environmental and topographic surfaces (rainfall, humidity and elevation) that help to predict the location and severity of RNC outbreaks
- We would recommend continuation of the virtual trial series

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