

# Dynamic Patch Analysis of Coastal Mangroves in Indonesia

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# Background

- Blue Forests is an Indonesia-based organization dedicated to Mangrove rehabilitation
- The organization uses Clark Labs data to understand where Mangroves used to be, and then target those former sites for restoration
- Former mangrove areas are most suitable for rehabilitating mangroves

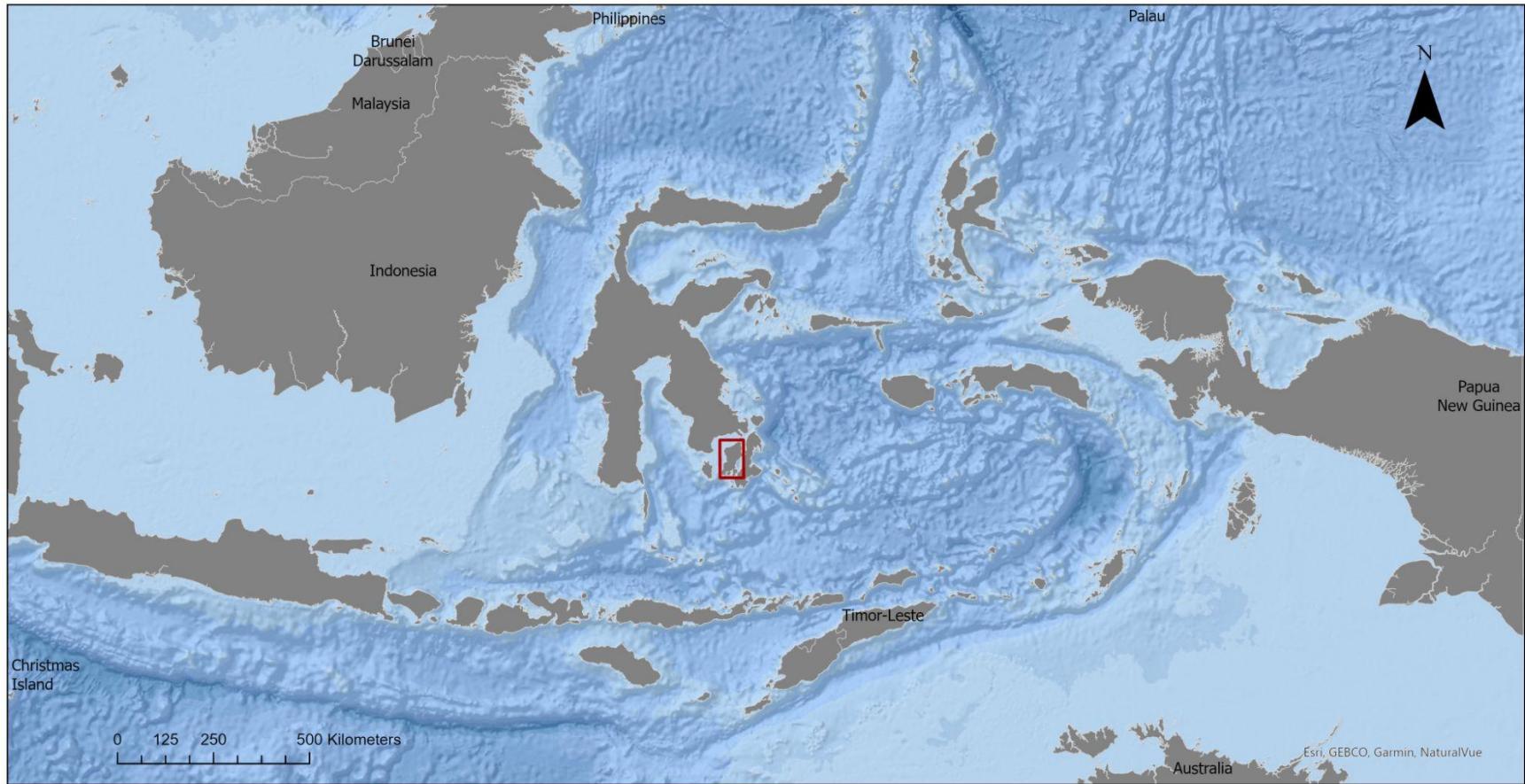


SOURCE: [Blue Forests](#)

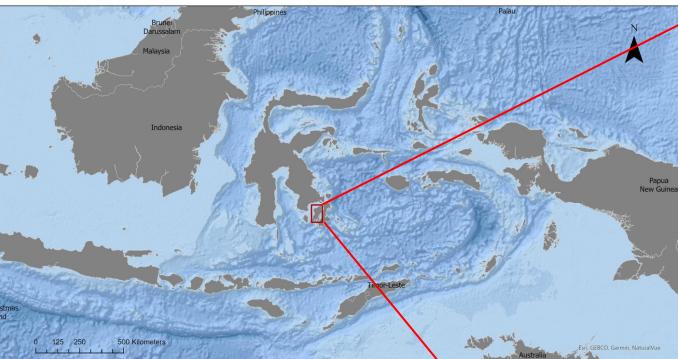
# Research Goals

- 1) Provide feedback to Aiyin Zhang about the utility of DynamicPATCH from a user-perspective
- 2) Provide additional data to Blue Forests about the dynamics of land change in areas most useful to them (primarily Muna Island)
- 3) Document a guide to using DynamicPATCH and show the results of our Muna Island case study on this [GitHub Repository](#)

# Study Area



Muna Island LC 1999



Land Cover data for  
Muna Island for the years  
1999   
2014  
2018  
2020  
2022

- 1. Mangrove
- 2. Coastal Wetland
- 3. Pond Aquaculture
- 4. Water
- 5. Other Land Cover
- 6. Missing

Muna Island LC 2014



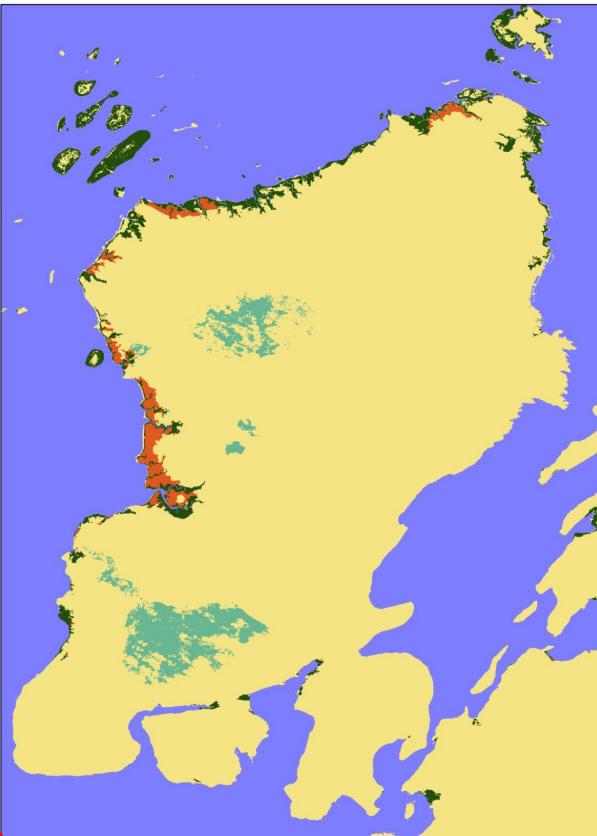
Land Cover data for  
Muna Island for the years  
1999  
2014 ←  
2018  
2020  
2022





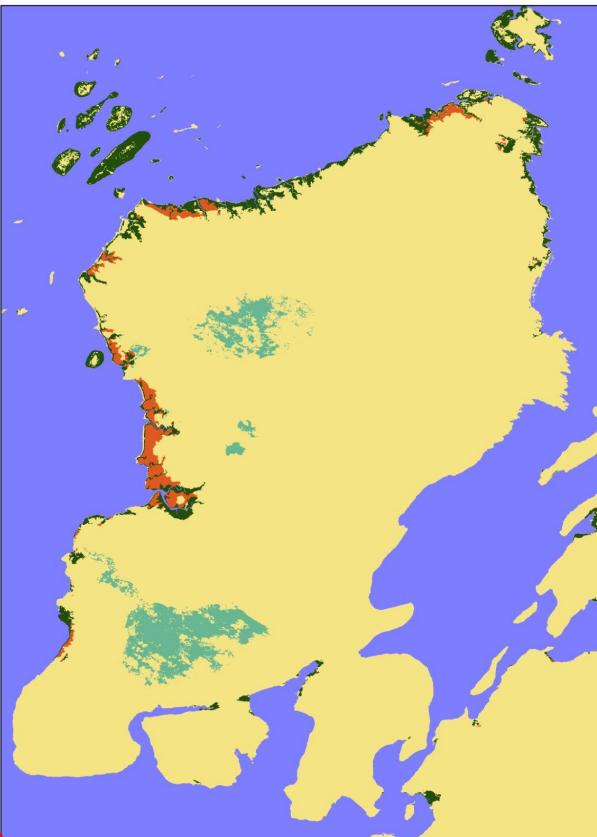
Land Cover data for  
Muna Island for the years  
1999  
2014  
2018 ←  
2020  
2022

Muna Island LC 2018



- 1. Mangrove
- 2. Coastal Wetland
- 3. Pond Aquaculture
- 4. Water
- 5. Other Land Cover
- 6. Missing

Muna Island LC 2020

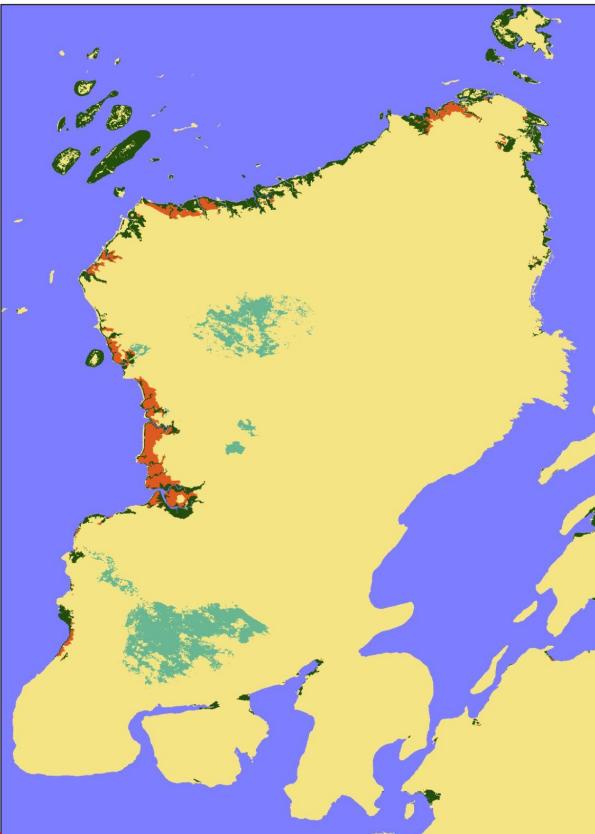


Land Cover data for  
Muna Island for the years  
1999  
2014  
2018  
**2020** ←  
2022

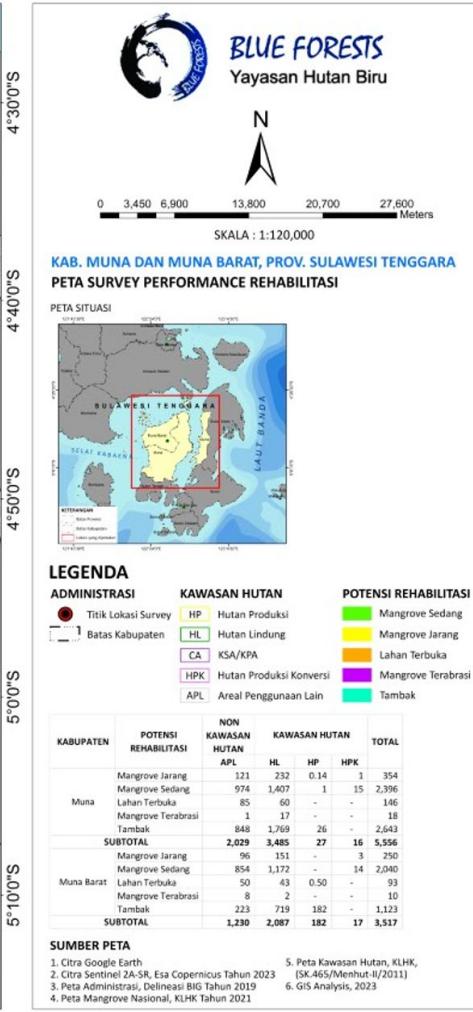
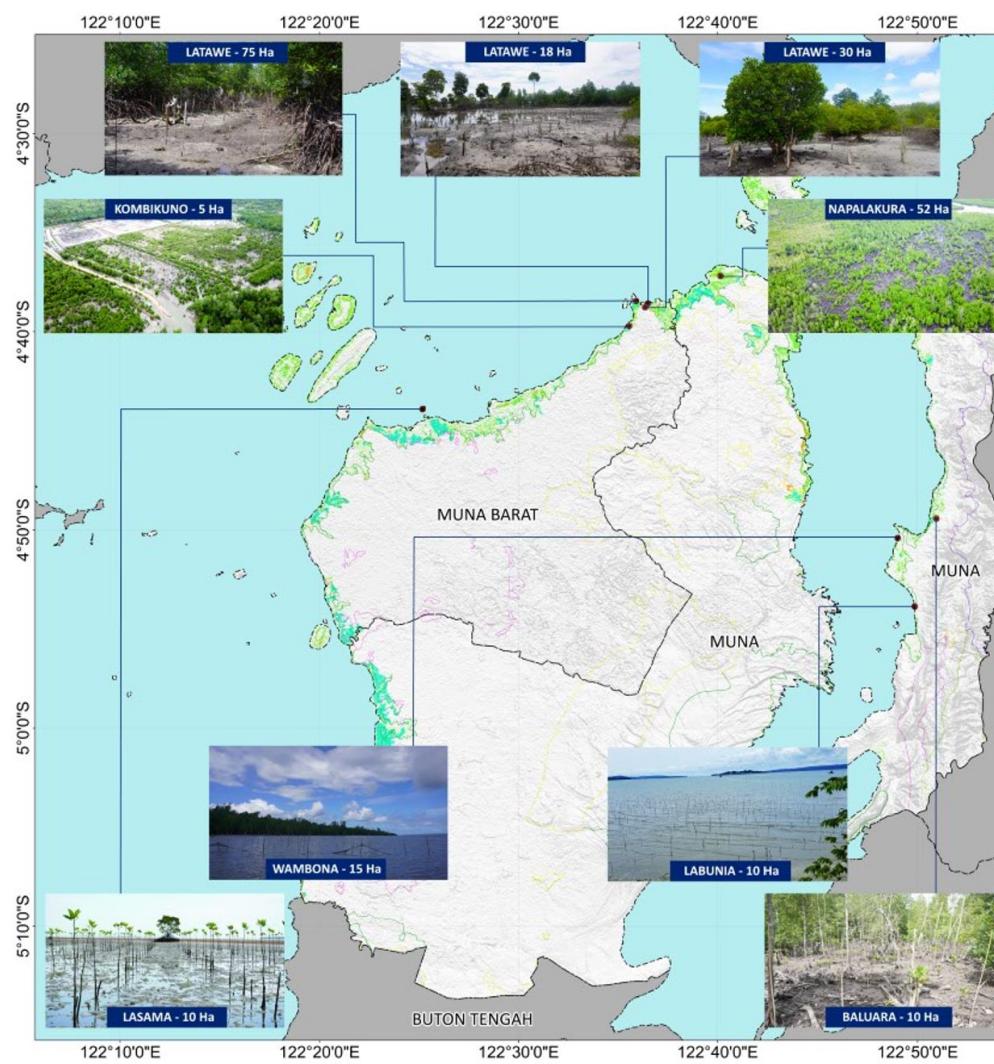
Muna Island LC 2022



Land Cover data for  
Muna Island for the years  
1999  
2014  
2018  
2020  
2022 ←



- 1. Mangrove
- 2. Coastal Wetland
- 3. Pond Aquaculture
- 4. Water
- 5. Other Land Cover
- 6. Missing

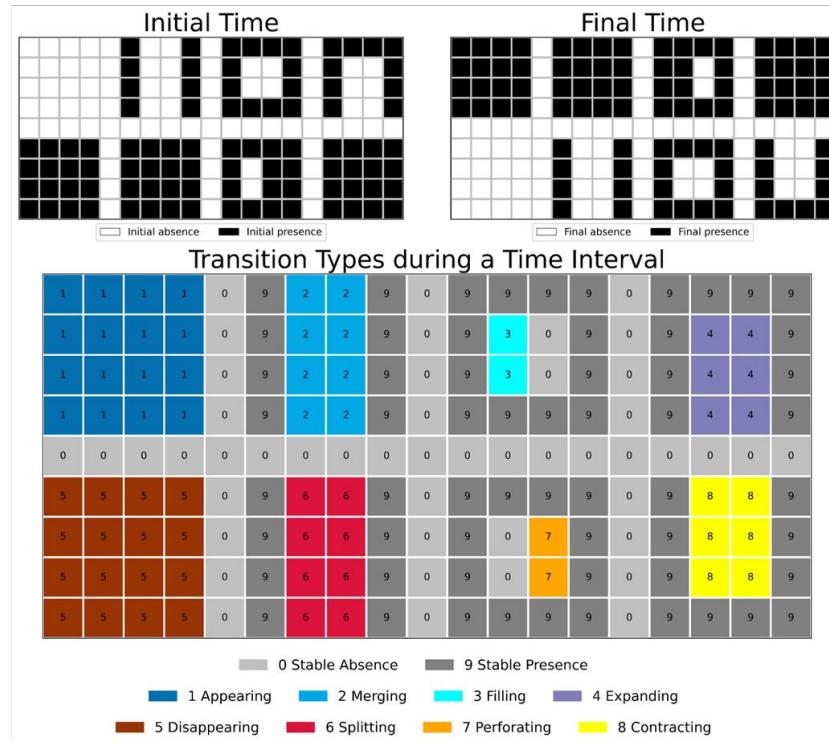


# Initial mangrove rehabilitation sites identified by Blue Forests

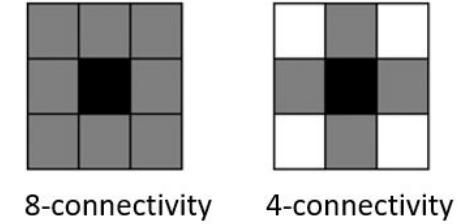
# About DynamicPATCH

## Spatially-explicit Dynamic Patch Transition Characterization

DynamicPATCH identifies eight patch-based transition types that are mutually exclusive and collectively exhaustive



Characterizing patch-transition types: a designed example



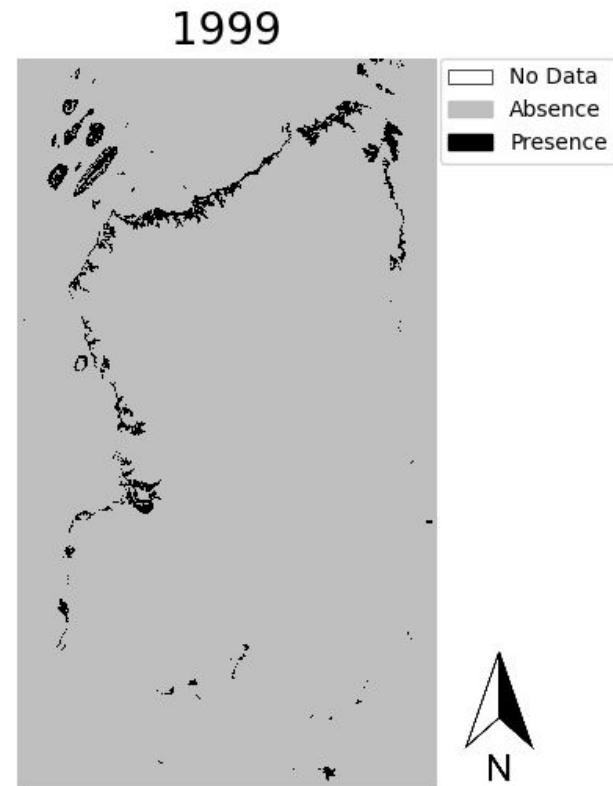
Two ways to define 'connected'

SOURCE: Aiyin Zhang

<https://github.com/zay1996/DynamicPATCH> 11

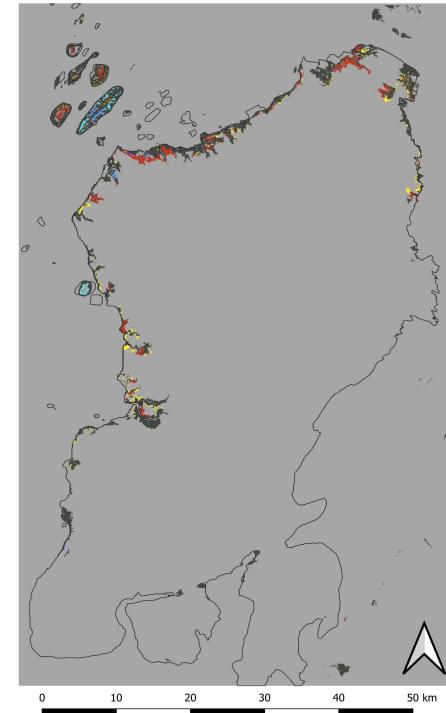
# Workflow

1. Installed DynamicPATCH package. It only worked on 2 out of 4 computers (there were issues with miniconda detection and the order of installation steps taken. We created our own, more detailed instructions that we hope are more useful.
2. Reclassified raw data to show Mangrove presence (1) and absence (0) for all time intervals. NoData values also had to be reclassified to 2 for the program to run.
3. Clipped the data to the extent of Muna Island

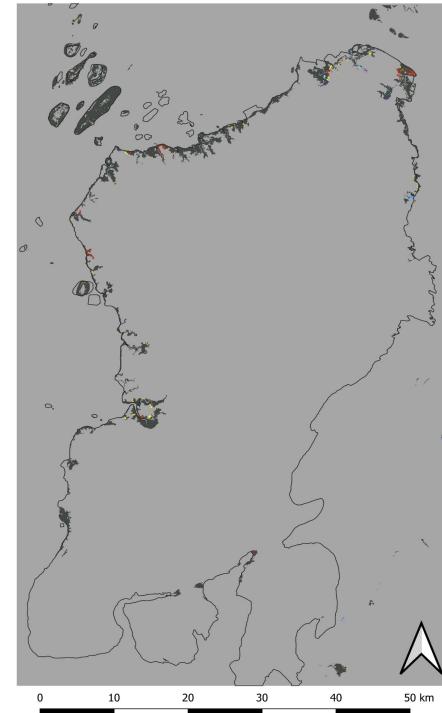


# DynamicPATCH - Full Extent

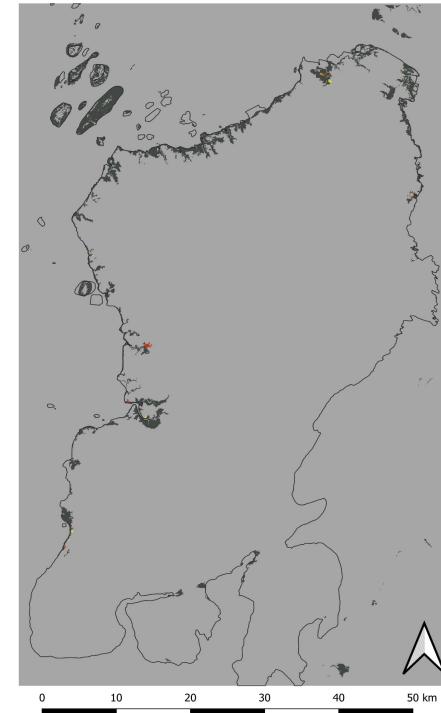
1990-2014 Transition Patterns



2014-2018 Transition Patterns



2018-2020 Transition Patterns



2020-2022 Transition Patterns



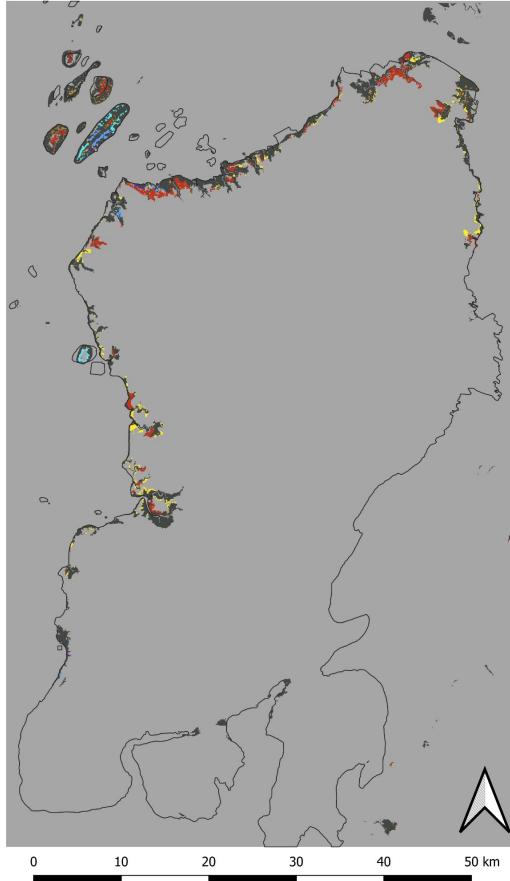
No Data  
Stable Absence  
Appearing  
Merging

Filling  
Expanding  
Disappearing  
Splitting

Perforating  
Contracting  
Stable Presence

# DynamicPATCH - Full Extent

## 1990-2014 Transition Patterns

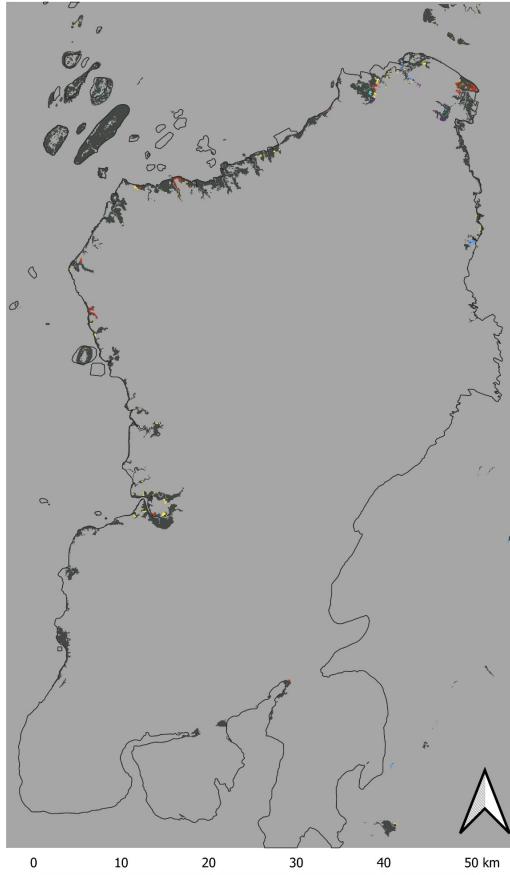


No Data
Stable Absence
Appearing
Merging
Filling
Expanding
Disappearing
Splitting
Perforating
Contracting
Stable Presence

Patch Type	Value	Pixel Count	Area (km <sup>2</sup> )
Stable Absence	0	24,624,757	5,537.17
Appearing	1	125	0.03
Merging	2	8,459	1.90
Filling	3	12,264	2.76
Expanding	4	2,814	0.63
Disappearing	5	1,665	0.37
Splitting	6	75,173	16.90
Perforating	7	11,210	2.52
Contracting	8	41,875	9.42
Stable Presence	9	508,722	114.39
	SUM	25,287,064	5,686.10

# DynamicPATCH - Full Extent

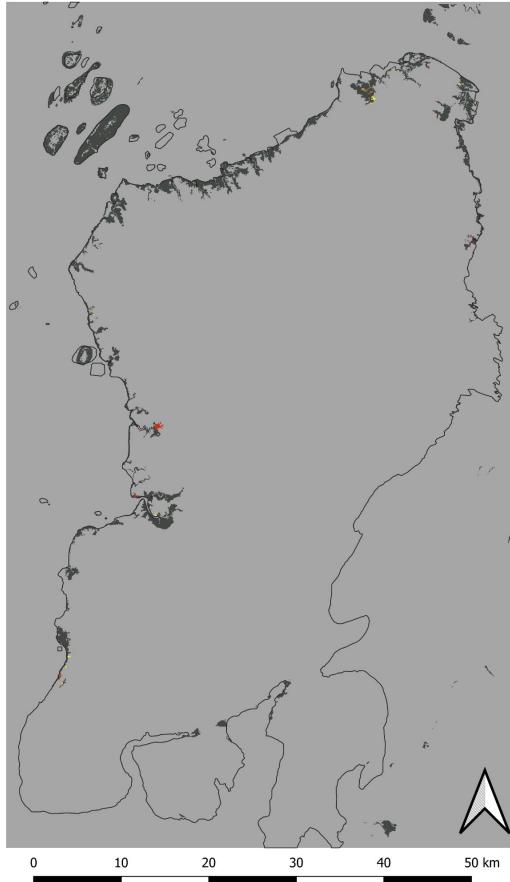
## 2014-2018 Transition Patterns



Patch Type	Value	Pixel Count	Area (km <sup>2</sup> )
Stable Absence	0	24,747,710	5,564.82
Appearing	1	475	0.11
Merging	2	2,690	0.60
Filling	3	1,574	0.35
Expanding	4	2,231	0.50
Disappearing	5	633	0.14
Splitting	6	9,524	2.14
Perforating	7	1,689	0.38
Contracting	8	7,907	1.78
Stable Presence	9	512,631	115.27
	SUM	25,287,064	5,686.10

# DynamicPATCH - Full Extent

## 2018-2020 Transition Patterns



No Data
Stable Absence
Appearing
Merging
Filling
Expanding
Disappearing
Splitting
Perforating
Contracting
Stable Presence

For this time interval:

Virtually no gain of Mangroves exist in this category

Only 74 expanding pixels

Patch Type	Value	Pixel Count	Area (km <sup>2</sup> )
Stable Absence	0	24,624,757	5,569.25
Appearing	1	0	0
Merging	2	0	0
Filling	3	0	0
Expanding	4	74	0.02
Disappearing	5	169	0.04
Splitting	6	4,028	0.91
Perforating	7	826	0.19
Contracting	8	1,905	0.43
Stable Presence	9	512,673	115.28
	SUM	25,287,064	5,686.10

# DynamicPATCH - Full Extent

## 2020-2022 Transition Patterns



No Data
Stable Absence
Appearing
Merging
Filling
Expanding
Disappearing
Splitting
Perforating
Contracting
Stable Presence

For this time interval:

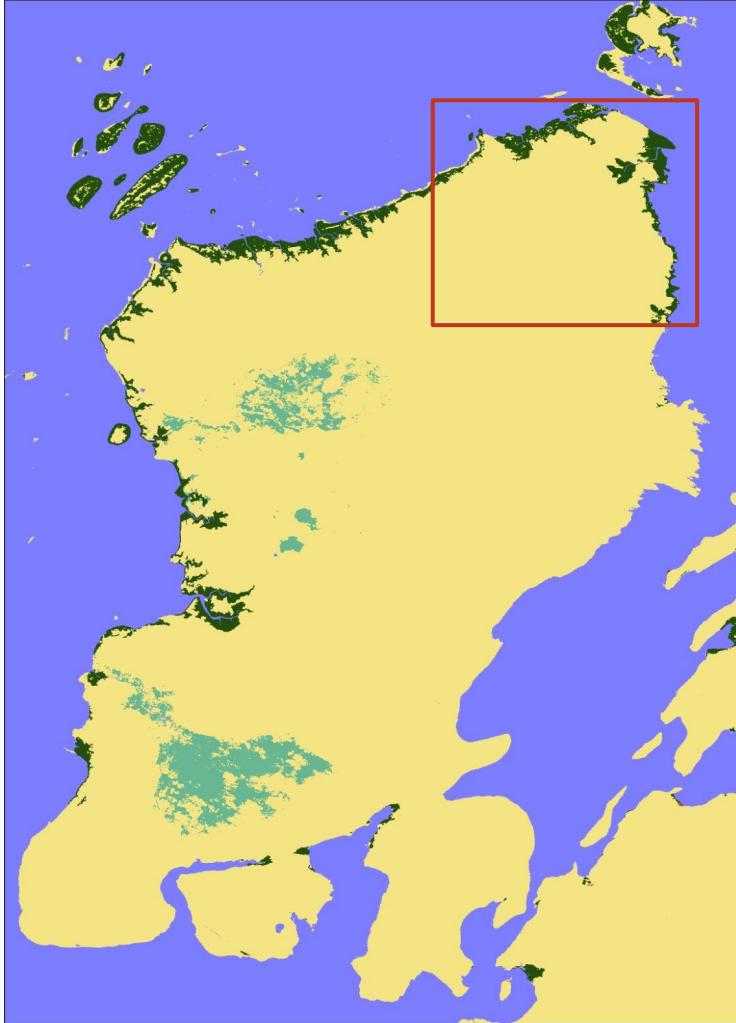
There is a small amount of gain for Merging and Expanding categories.

No new appearing pixels

Patch Type	Value	Pixel Count	Area (km <sup>2</sup> )
Stable Absence	0	24,773,837	5,570.70
Appearing	1	0	0
Merging	2	290	0.07
Filling	3	0	0
Expanding	4	190	0.04
Disappearing	5	20	0.00
Splitting	6	557	0.13
Perforating	7	2	0.00
Contracting	8	1,933	0.43
Stable Presence	9	510,235	114.73
	SUM	25,287,064	5,686.10

# Focus Area 1: Northeast

- 1. Mangrove
- 2. Coastal Wetland
- 3. Pond Aquaculture
- 4. Water
- 5. Other Land Cover
- 6. Missing

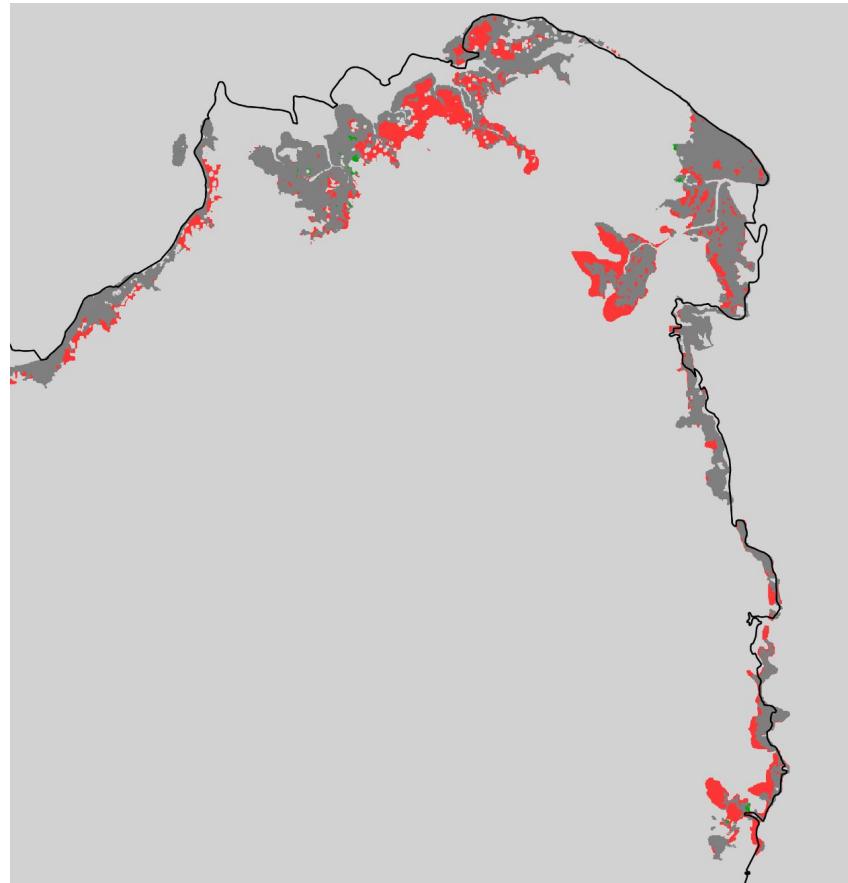


We set the focus on a smaller extent within the study area to highlight the transition patches generated by the package.

# Extent Northeast

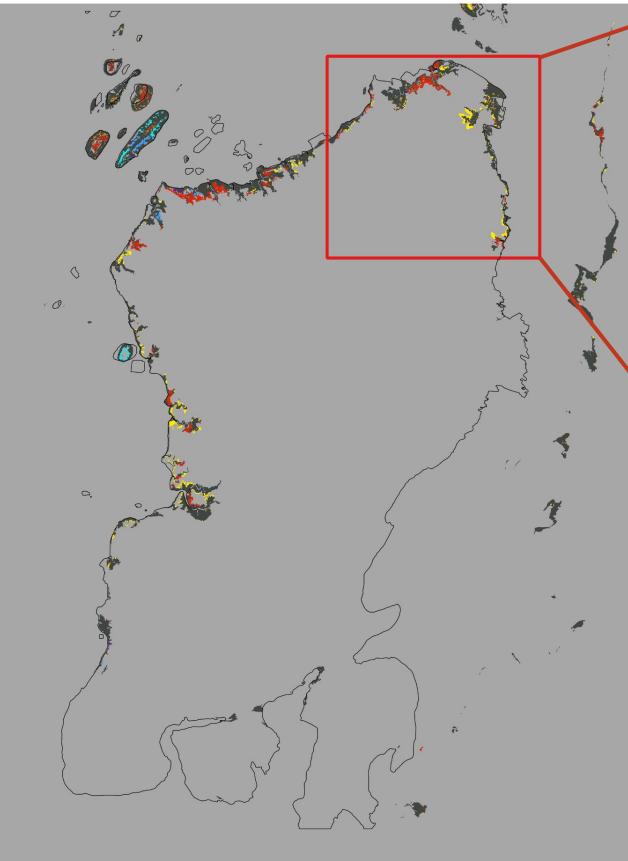
1999-2014 Mangrove Change

- Stable Absence
- Mangrove Loss
- Mangrove Gain
- Stable Presence



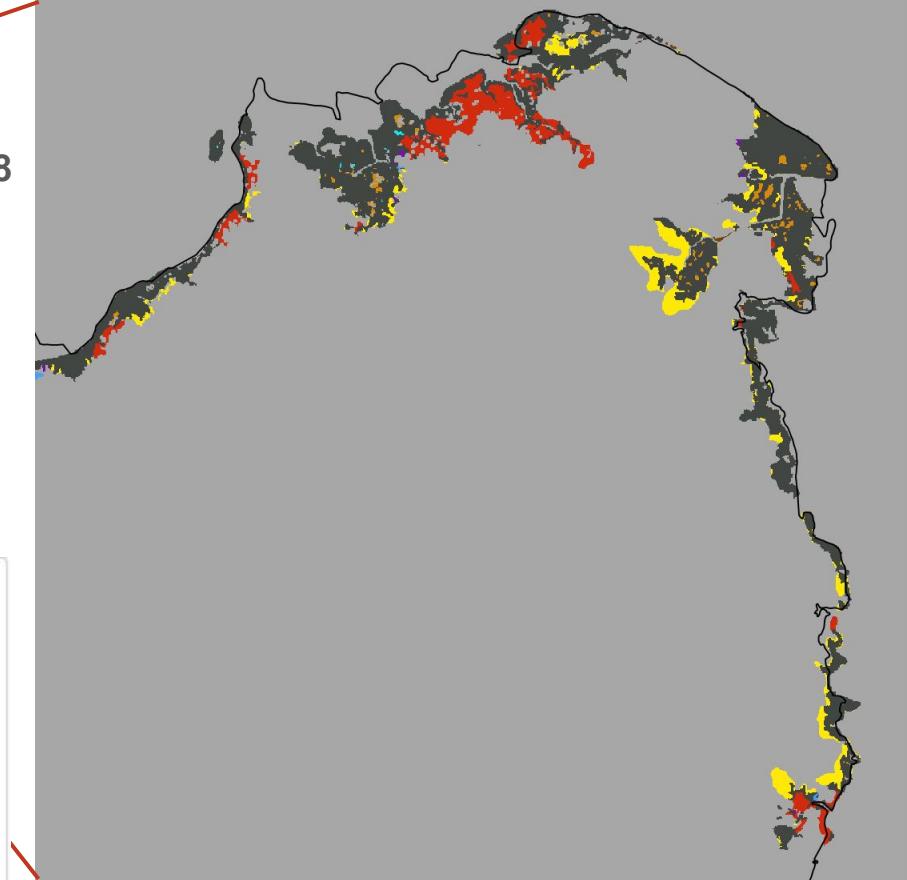
# DynamicPATCH - Northeast

1999-2014 Transition Patterns



Connectivity = 8

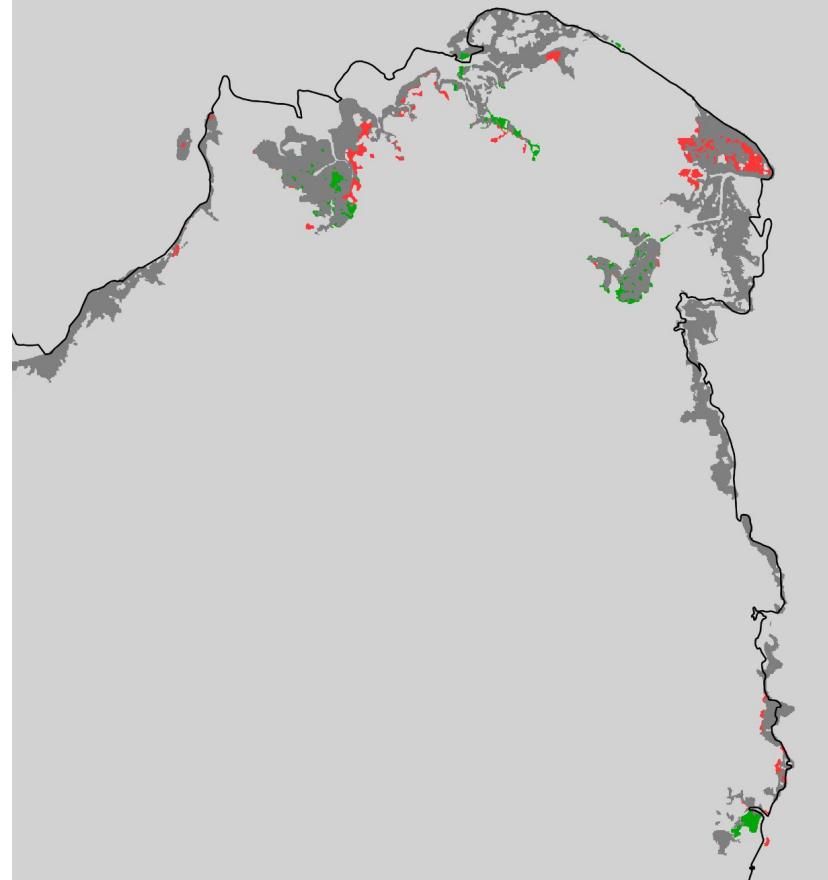
- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
- Disappearing
- Splitting
- Perforating
- Contracting
- Stable Presence



# Extent Northeast

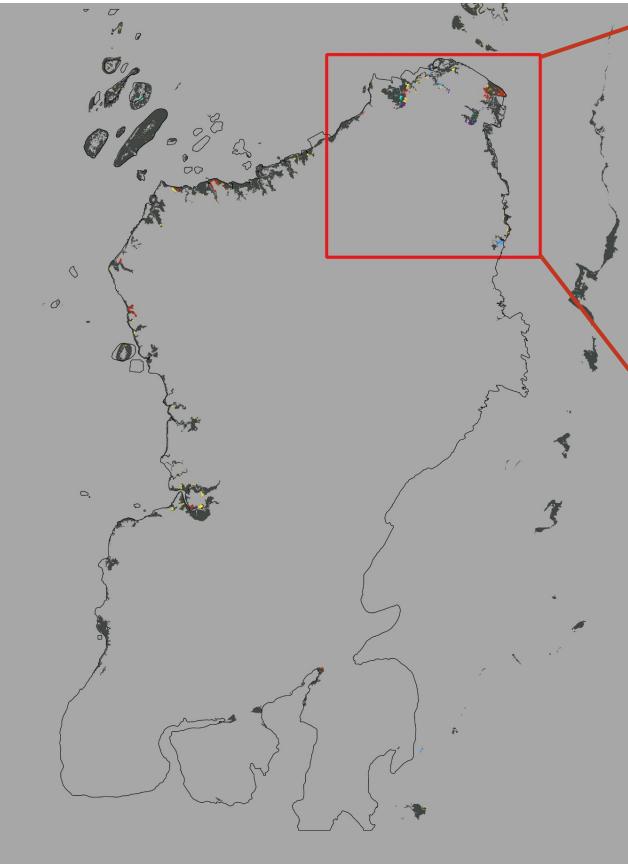
## 2014-2018 Mangrove Change

- Stable Absence
- Mangrove Loss
- Mangrove Gain
- Stable Presence



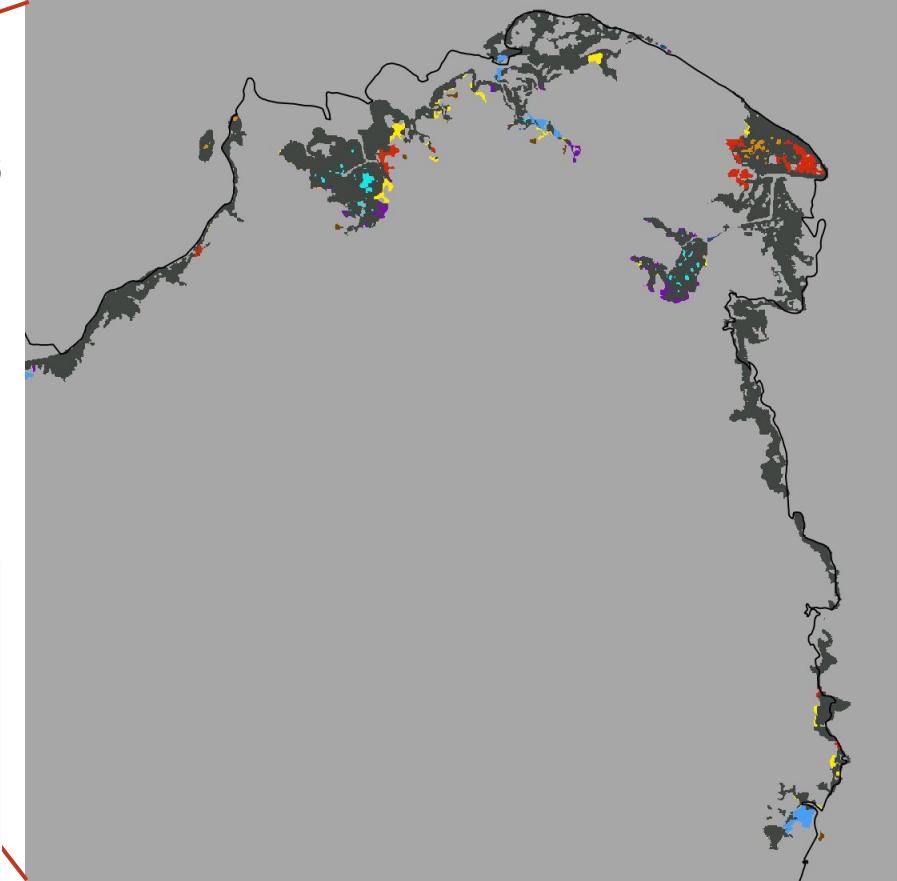
# DynamicPATCH - Northeast

2014-2018 Transition Patterns



Connectivity = 8

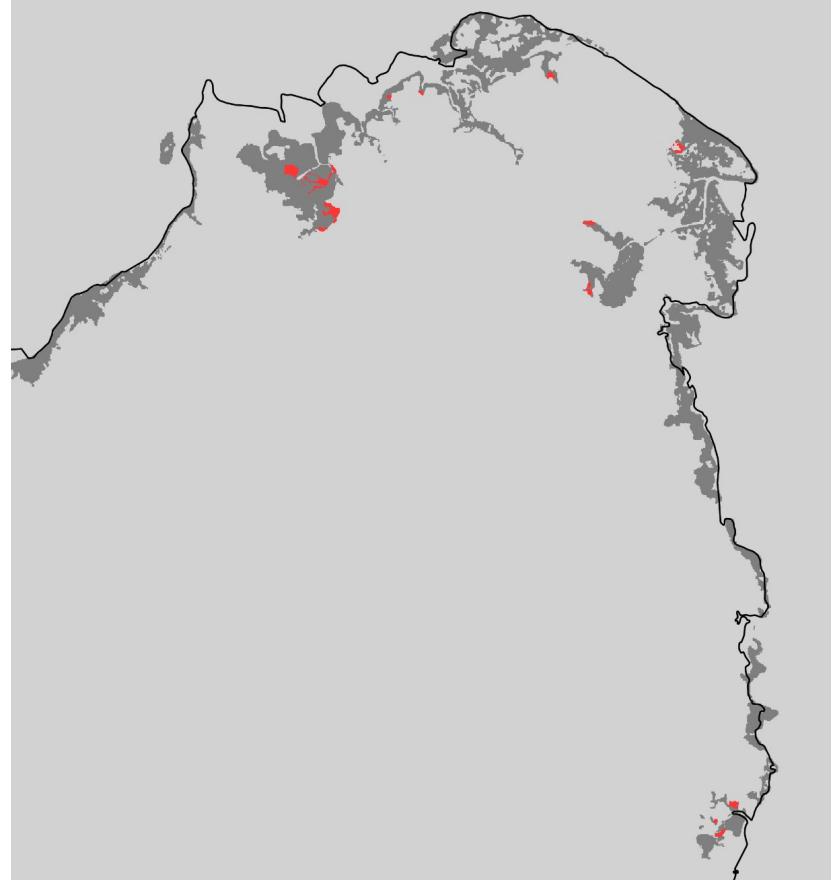
- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
- Disappearing
- Splitting
- Perforating
- Contracting
- Stable Presence



# Extent Northeast

## 2018-2020 Mangrove Change

- Stable Absence
- Mangrove Loss
- Mangrove Gain
- Stable Presence



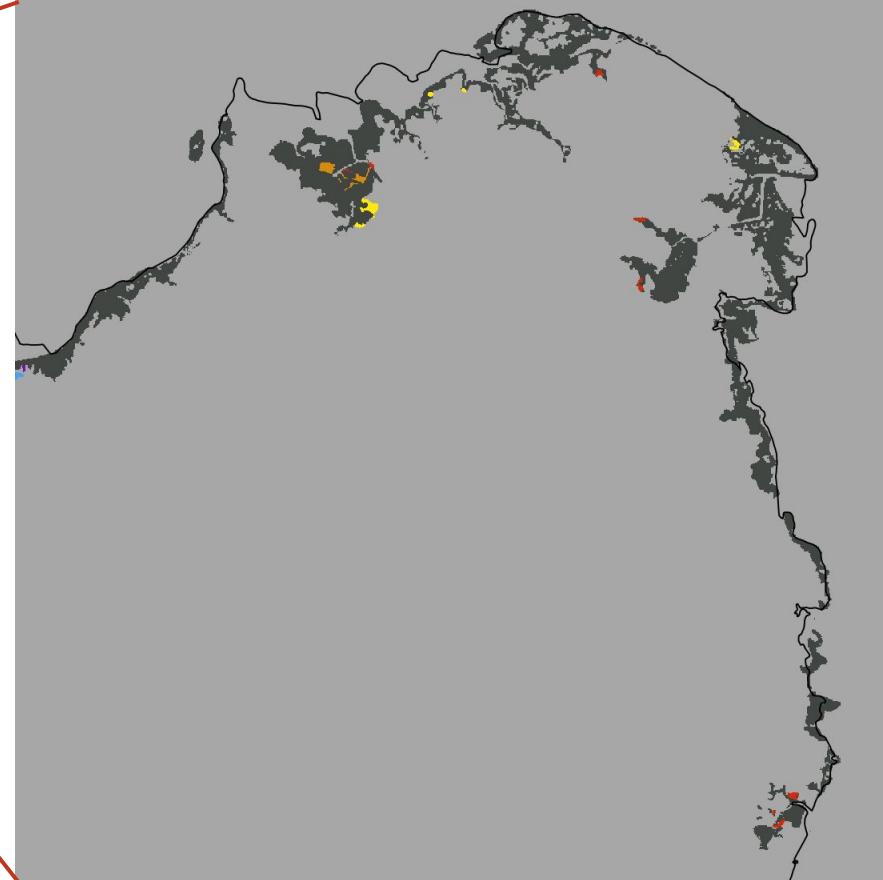
# DynamicPATCH - Northeast

2018-2020 Transition Patterns



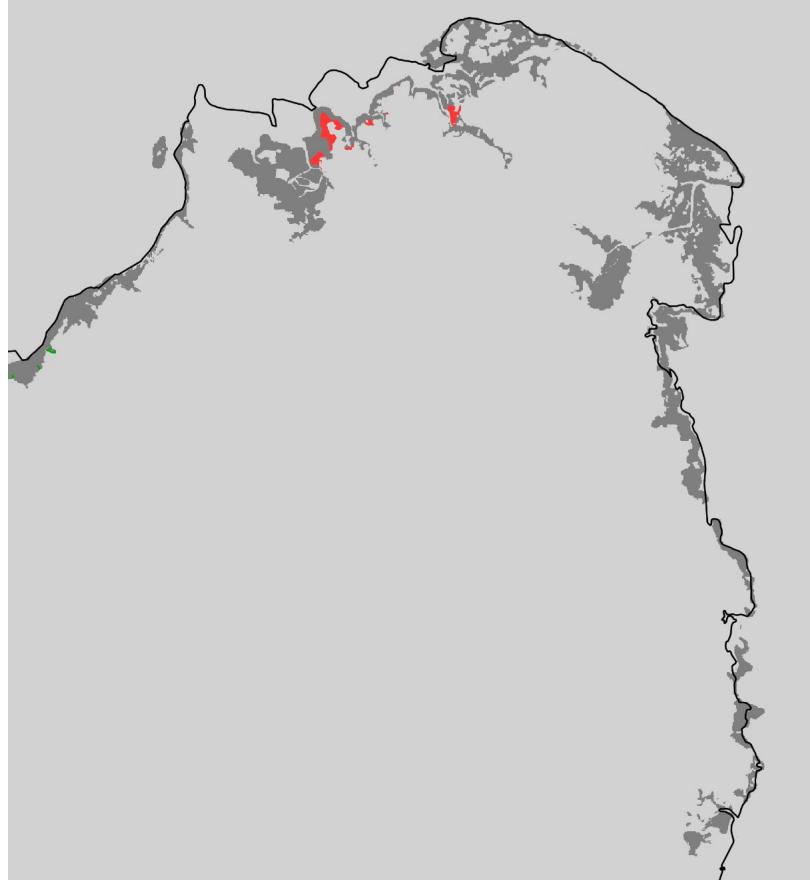
Connectivity = 8

- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
- Disappearing
- Splitting
- Perforating
- Contracting
- Stable Presence



# Extent Northeast

## 2020-2022 Mangrove Change



# DynamicPATCH - Northeast

2020-2022 Transition Patterns



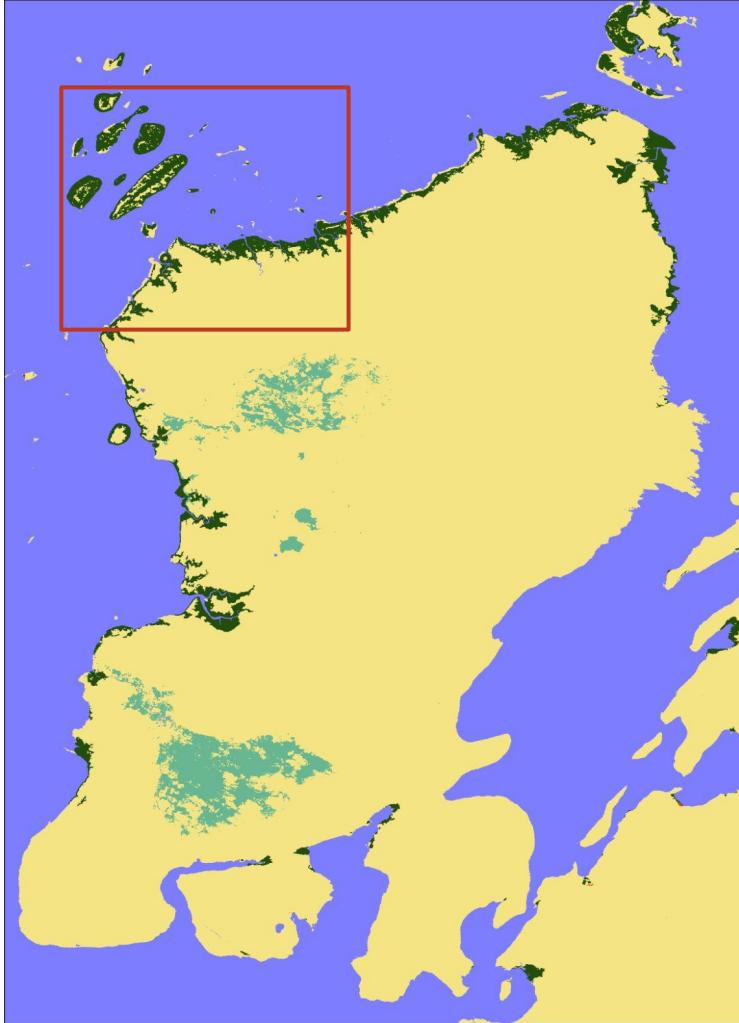
Connectivity = 8

- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
- Disappearing
- Splitting
- Perforating
- Contracting
- Stable Presence



# Focus Area 1: Northwest

- 1. Mangrove
- 2. Coastal Wetland
- 3. Pond Aquaculture
- 4. Water
- 5. Other Land Cover
- 6. Missing

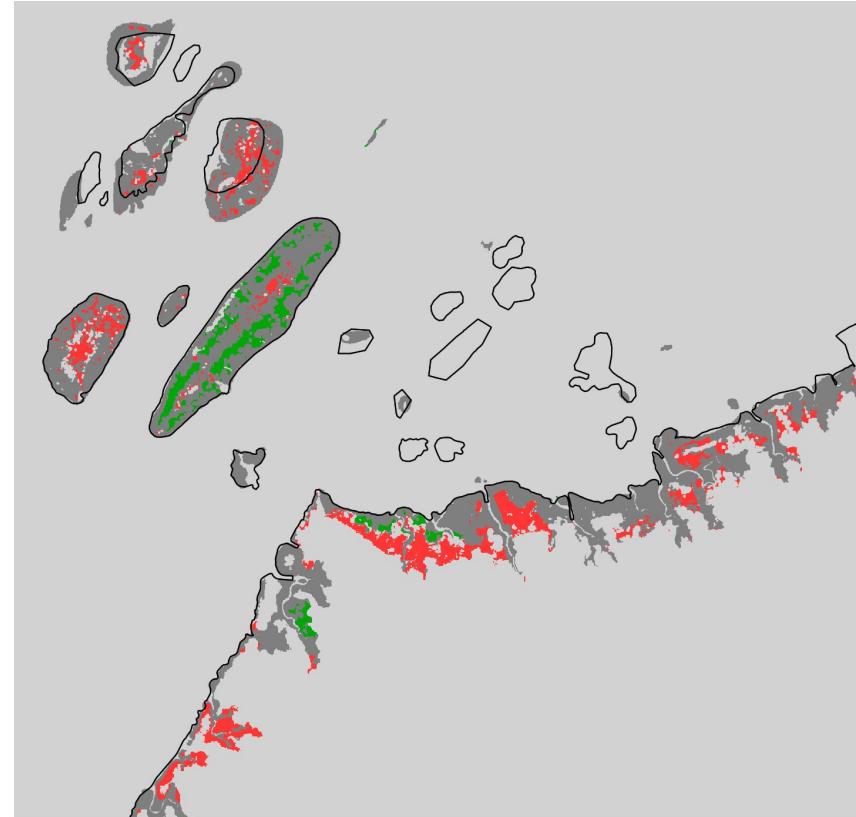


We set the focus on a smaller extent within the study area to highlight the transition patches generated by the package.

# Extent Northwest

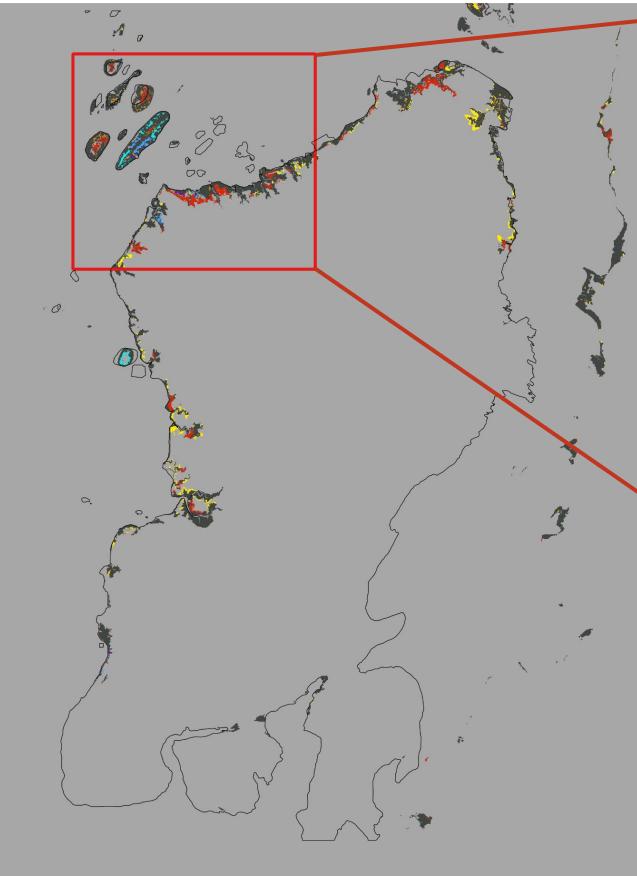
1999-2014 Mangrove Change

- Stable Absence
- Mangrove Loss
- Mangrove Gain
- Stable Presence



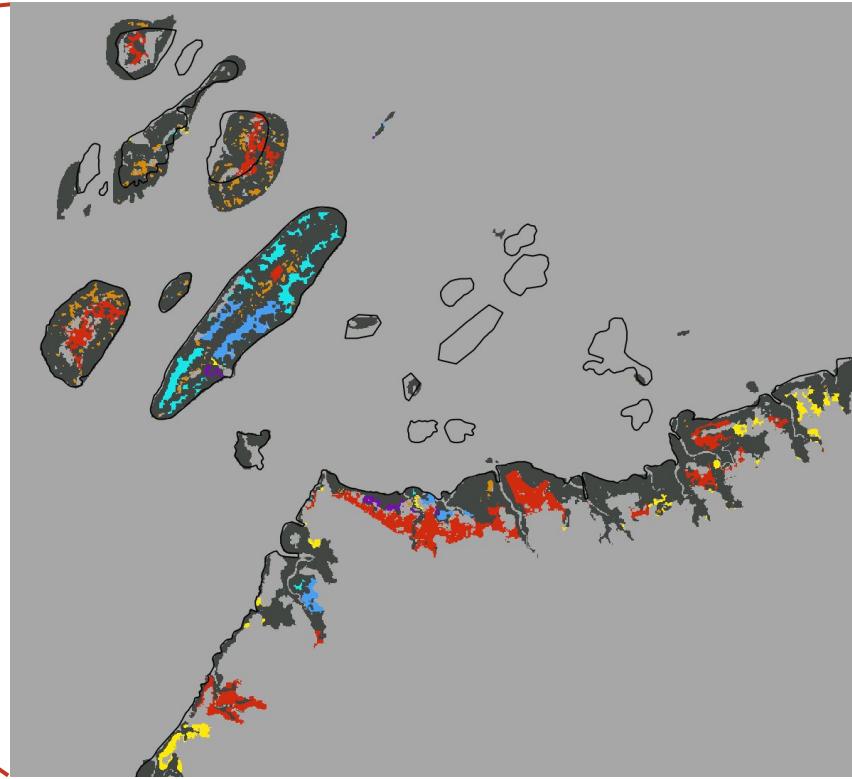
# DynamicPATCH - Northwest

1999-2014 Transition Patterns



Connectivity = 8

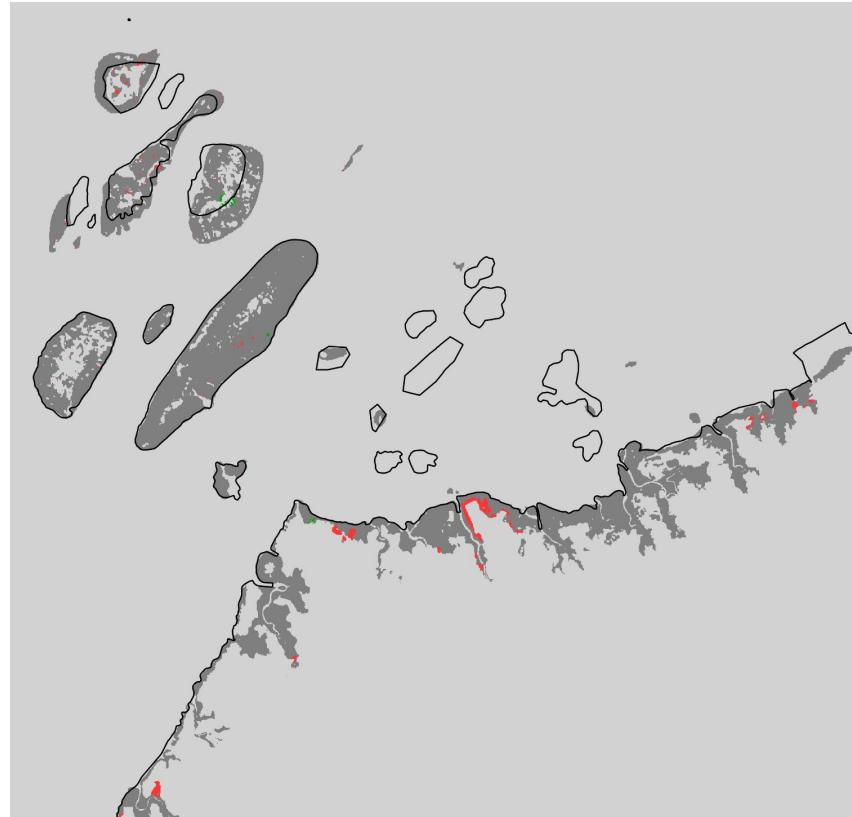
- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
- Disappearing
- Splitting
- Perforating
- Contracting
- Stable Presence



# Extent Northwest

## 2014-2018 Mangrove Change

- Stable Absence
- Mangrove Loss
- Mangrove Gain
- Stable Presence



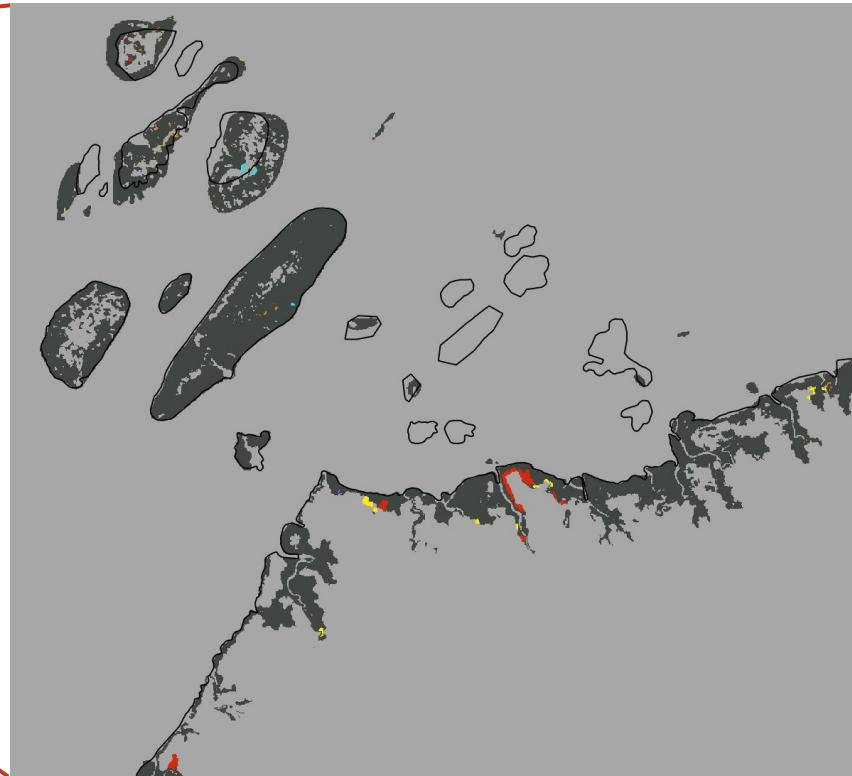
# DynamicPATCH - Northwest

2014-2018 Transition Patterns



Connectivity = 8

- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
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# Extent Northwest

## 2018-2020 Mangrove Change

- Stable Absence
- Mangrove Loss
- Mangrove Gain
- Stable Presence



# DynamicPATCH - Northwest

## 2018-2020 Transition Patterns



Connectivity = 8

- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
- Disappearing
- Splitting
- Perforating
- Contracting
- Stable Presence



# Extent Northwest

## 2020-2022 Mangrove Change

- Stable Absence
- Mangrove Loss
- Mangrove Gain
- Stable Presence



# DynamicPATCH - Northwest

## 2020-2022 Transition Patterns



Connectivity = 8

- No Data
- Stable Absence
- Appearing
- Merging
- Filling
- Expanding
- Disappearing
- Splitting
- Perforating
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- Stable Presence

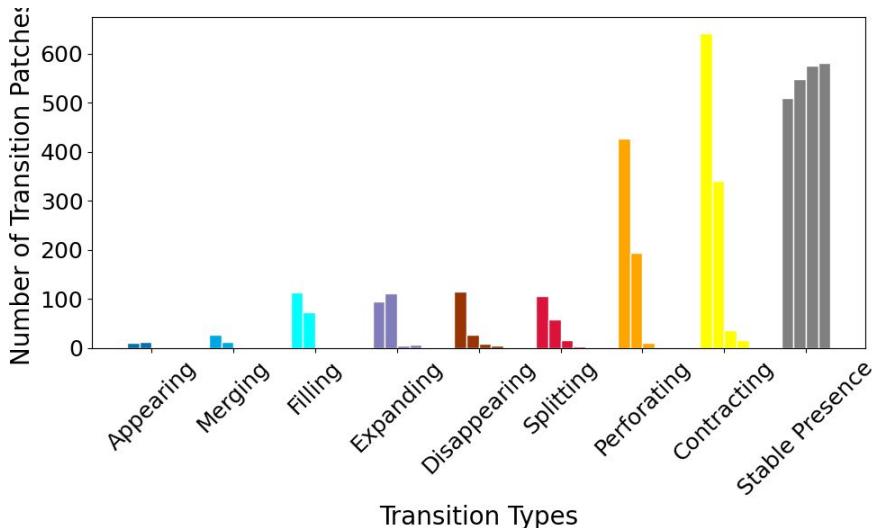


# Mangrove Change Over the Entire Spatial and Temporal Extent

Patch Type	Pixel Count	Area (km2)
Appearing	600	0.14
Merging	11,439	2.57
Filling	13,838	3.11
Expanding	5,309	1.19
Disappearing	2,487	0.55
Splitting	89,282	20.08
Perforating	13,727	3.09
Contracting	53,620	12.06
<b>Gross Gain</b>	<b>31,186</b>	<b>7.01</b>
<b>Gross Loss</b>	<b>159,116</b>	<b>35.78</b>
<b>Net Change</b>	<b>-127,930</b>	<b>-28.77</b>

# Results from DynamicPATCH (Connectivity 4, Full Extent)

Number of Transition Patches for Each Transition Type



Each bar represents a time interval

A high number of contracting patches, especially from 1999-2014, indicates loss within patches of stable presence.

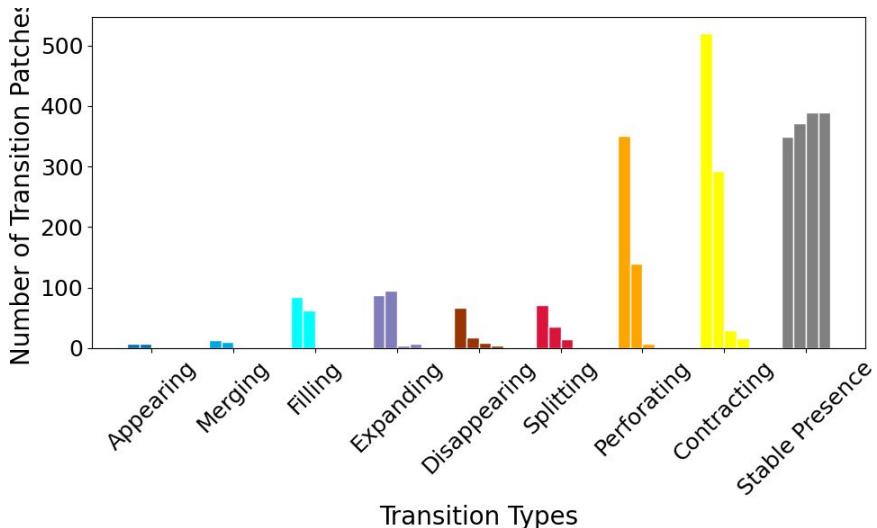


A high number of perforating patches, also from 1999-2014 and 2014-2018, indicates “gaps” of absence within patches of presence are increasing. This however does not change the overall number of patches.



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A high number of contracting patches, especially from 1999-2014, indicates loss within patches of stable presence.

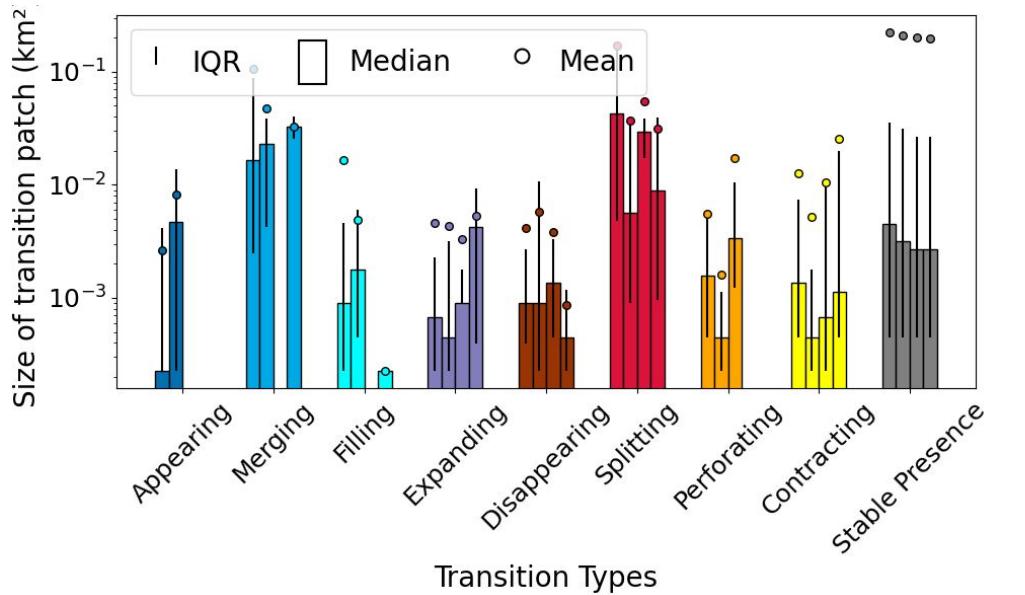


A high number of perforating patches, also from 1999-2014 and 2014-2018, indicates “gaps” of absence within patches of presence are increasing. This however does not change the overall number of patches.



# Results from DynamicPATCH (Connectivity 4, Full Extent)

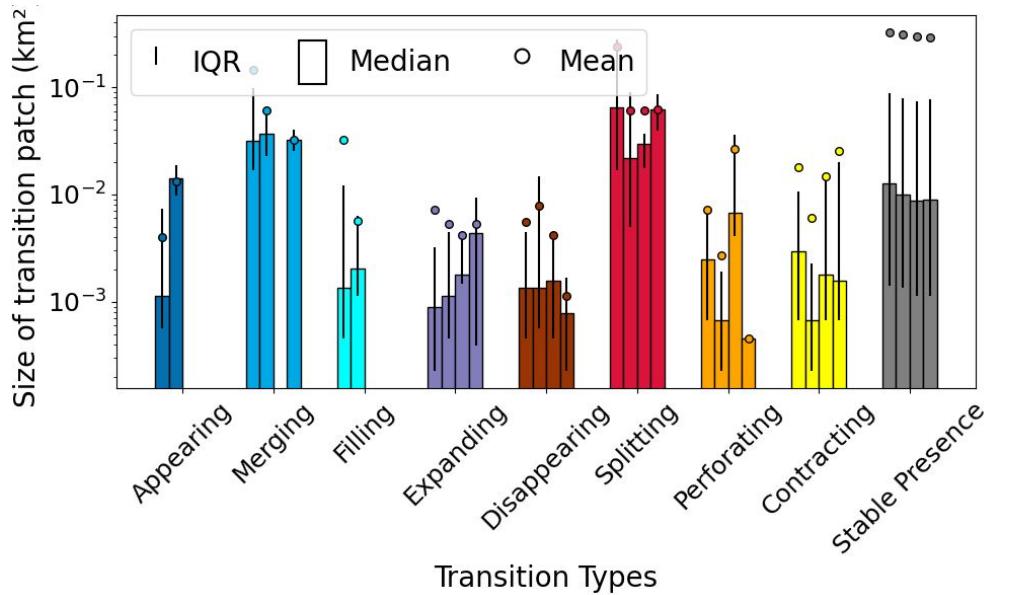
Distribution of Transition  
Patch Sizes



On average, transition patches that experience splitting as a transition type are largest

# Results from DynamicPATCH (Connectivity 8, Full Extent)

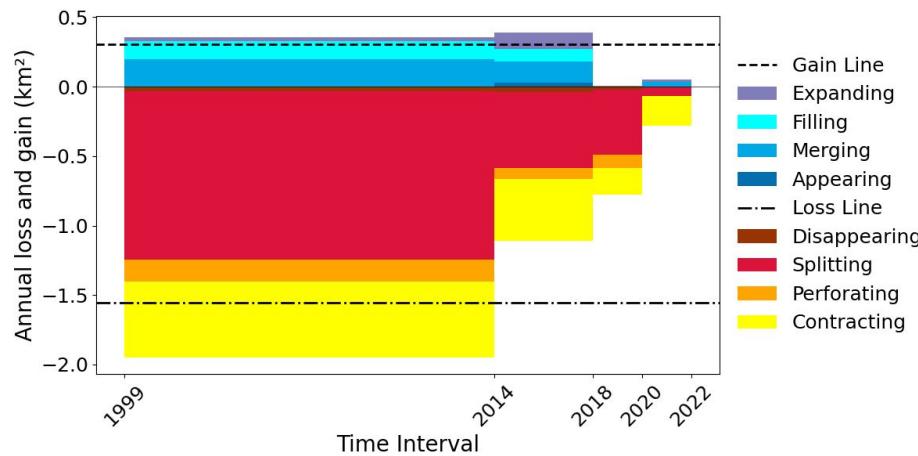
Distribution of Transition  
Patch Sizes



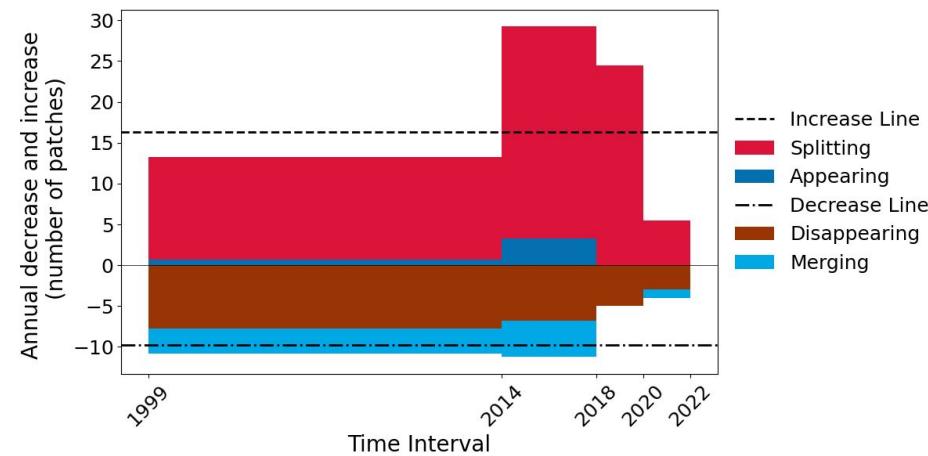
On average, transition patches that experience splitting as a transition type are largest

# Results from DynamicPATCH (Connectivity 4, Full Extent)

Annual Gross Loss and Gross Gain by Transition Types



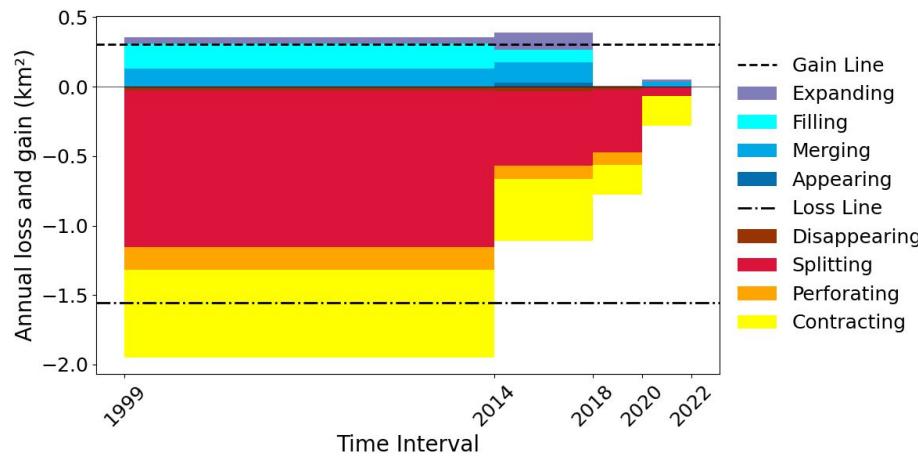
Annual Gross Increase and Decrease in Number of Patches



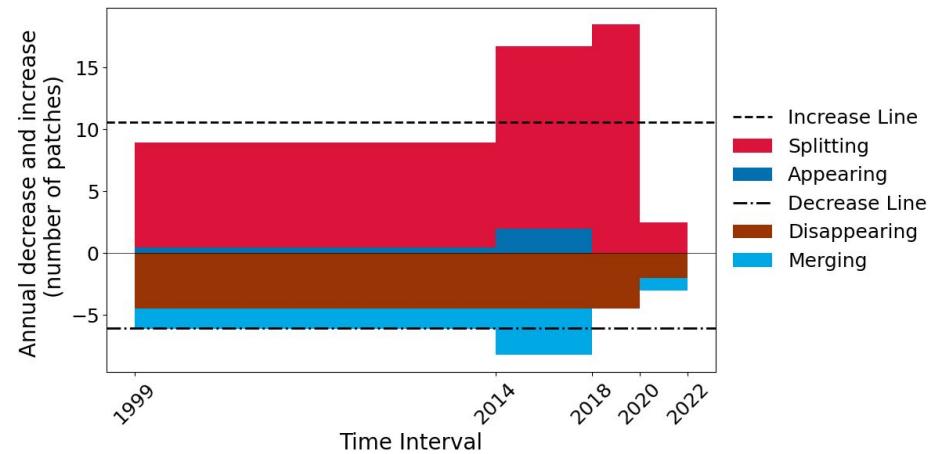
Possible impacts: Splitting, perforating and contracting of patches promotes habitat fragmentation in mangrove ecosystems, even if net loss is low  
→ edge effects  
→ potential threat to ecosystem (Bryan-Brown, Dale N., et al. (2020))

# Results from DynamicPATCH (Connectivity 8, Full Extent)

Annual Gross Loss and Gross Gain by Transition Types



Annual Gross Increase and Decrease in Number of Patches



Possible impacts: Splitting, perforating and contracting of patches promotes habitat fragmentation in mangrove ecosystems, even if net loss is low  
→ edge effects  
→ potential threat to ecosystem (Bryan-Brown, Dale N., et al. (2020))

# Challenges and Feedback for Aiyin

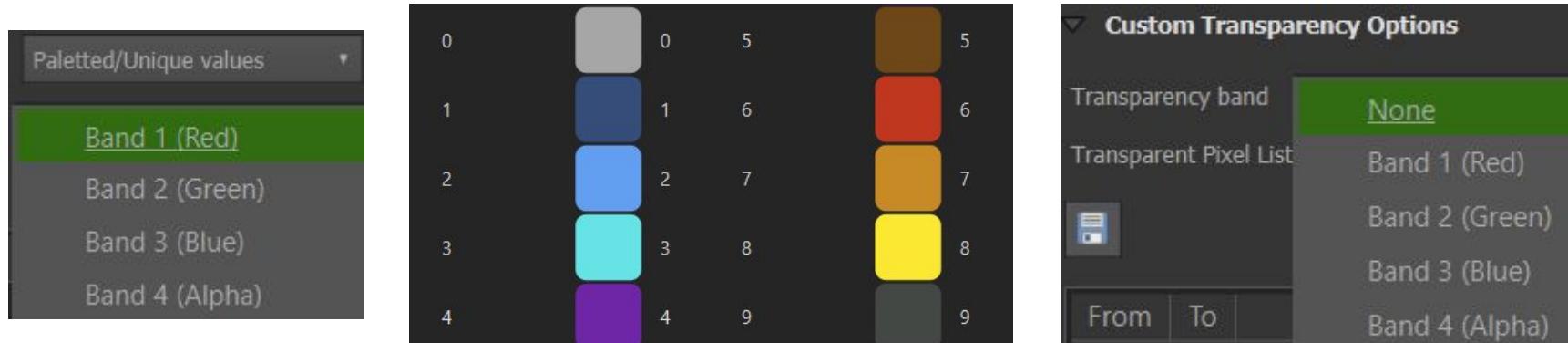
1. Good understanding of programming and command line required
2. Downloading the package was difficult and we were not all able to run it. We think issues are related to location of virtual environment and Python version
3. Issues with NoData values: The default values for NoData did not work out of the box. We had to reclassify no-data to a value of 2 in order for the inputs to work correctly. This could be included in the documentation to make it easier for the user to understand the model.
4. Various bugs with GUI and when running the script via command-line

# Challenges and Initial Feedback for Aiyin

5. After exporting as a GEOTIFF file, the documentation of the package is not clear on how to visualize the data.

Each band represents a time interval. 4 time intervals = 4 bands. We individually displayed each band in a layer to recreate the output shown in the program.

We also had to remove the QGIS default transparency band to visualize results



# Remaining Improvements to DynamicPATCH

- We recommend that Aiyan adds an argument that enables the user to scale the output graphs
- When using the GUI, the 4 and 8 connectivity option does not make a difference. The program defaults to 8 connectivity.
- Trying to export the maps using the command-line argument “**export = true**” as a .geotiff doesn’t work and the graphs do not display

# References

- Blue Forests. (n.d.). *Our approach*. Blue Forests. Retrieved November 17, 2024, from <https://blue-forests.org/en/about-us/our-approach/>
- Bryan-Brown, D. N., Connolly, R. M., Richards, D. R., Adame, F., Friess, D. A., & Brown, C. J. (2020). Global trends in mangrove forest fragmentation. *Scientific reports*, 10(1), 7117.
- Zhang, A. (2020, July 6). DynamicPATCH (Version 1.0) [Software]. GitHub. <https://github.com/zay1996/DynamicPATCH>
- Zhang, A. (2024). Novel methods to characterize spatially-explicit patch dynamics on a landscape [Slideshow].