

Assessing intertidal mussel bed patch dynamics under thermal stress with computer vision

Yi-Fei Gu^{1,2}, Gray A. Williams¹

¹The Swire Institute of Marine Science and School of Biological Sciences
The University of Hong Kong, Pokfulam, Hong Kong SAR, China

²Marine Science Center, Northeastern University, Nahant, MA, USA





Original article

Mussels as ecosystem engineers: Their contribution to species richness in a rocky littoral community

Ana Inés Borthagaray^{*,1}, Alvar Carranza¹

Investigación and Desarrollo, Facultad de Ciencias, Iguá 4225, CP 11 400, Montevideo, Uruguay

ORIGINAL RESEARCH article

Front. Mar. Sci., 04 August 2022

Sec. Marine Biology

<https://doi.org/10.3389/fmars.2022.929>

899

Mussels and canopy-forming algae as ecosystem engineers: their contribution to community organization in the rocky sublittoral



Mats Westerborn^{1,2*} and



Maria Koivisto²

¹ Natural Resource Institute Finland Luonnonvarakeskus (LUKE), Turku, Finland

² Tvärminne Zoological Station, Helsinki University, Hangö, Finland

Mussels as a Model System for Integrative Ecomechanics

Emily Carrington,¹ J. Herbert Waite,² Gianluca Sarà,³ and Kenneth P. Sebens¹

¹Department of Biology and Friday Harbor Laboratories, University of Washington, Friday Harbor, Washington 98250; email: ecarring@uw.edu, sebens@uw.edu

²Department of Molecular, Cellular, and Developmental Biology, University of California, Santa Barbara, California 93106; email: waite@lifesci.ucsb.edu

³Dipartimento di Scienze della Terra e del Mare, University of Palermo, 90128 Palermo, Italy; email: gianluca.sara@unipa.it



ELSEVIER

Journal of Experimental Marine Biology and Ecology 316 (2005) 133–147

**Journal of
EXPERIMENTAL
MARINE BIOLOGY
AND ECOLOGY**

www.elsevier.com/locate/jembe

Mussels matter: postlarval dispersal dynamics altered by a spatially complex ecosystem engineer

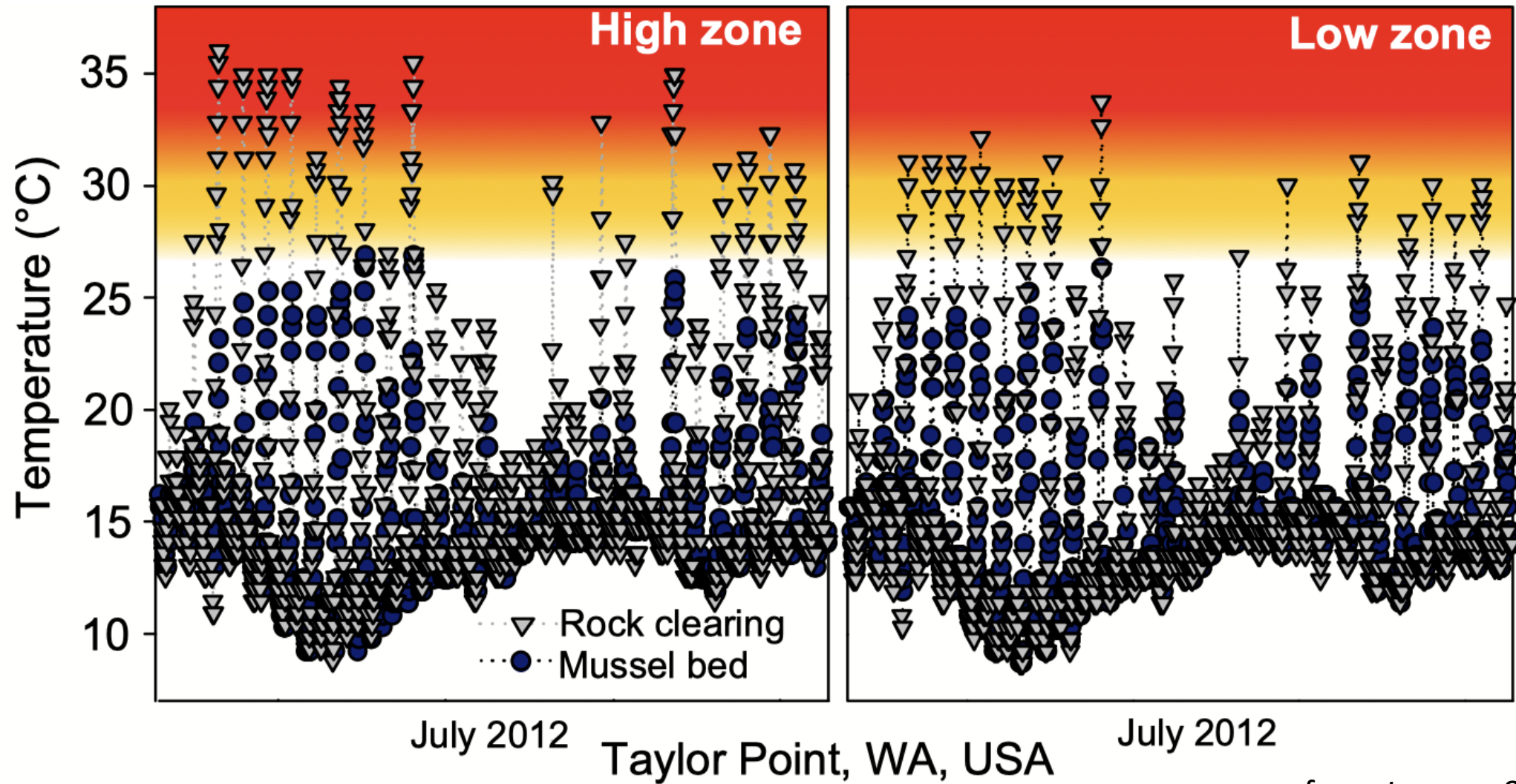
John A. Commito^{a,b,*}, Emily A. Celano^a, Holly J. Celico^c,
Serena Como^b, Craig P. Johnson^a

^aEnvironmental Studies Department, Gettysburg College, Gettysburg, PA 17325, USA

^bDipartimento di Scienze dell'Uomo e dell'Ambiente, Università di Pisa, Via Volta 6, I-56126 Pisa, Italy

^cBiology Department, Gettysburg College, Gettysburg, PA 17325, USA

Thermally 'benign' mussel bed bio-habitats



July 2012

Taylor Point, WA, USA

July 2012

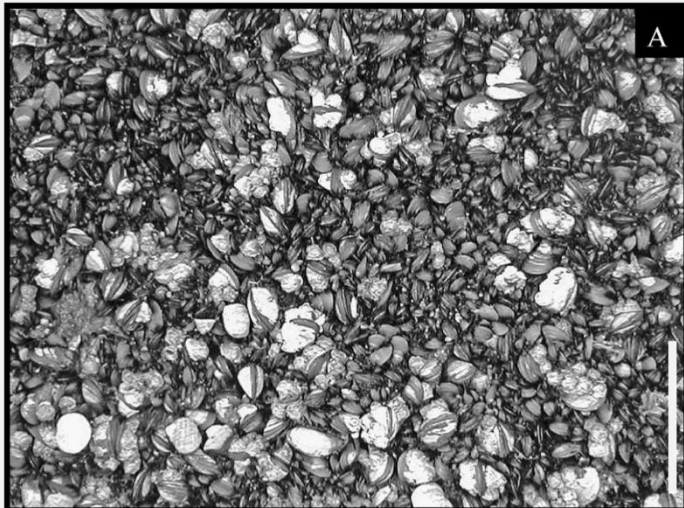
from *Jurgens & Gaylord, 2018*

Mussel beds facilitate intertidal communities

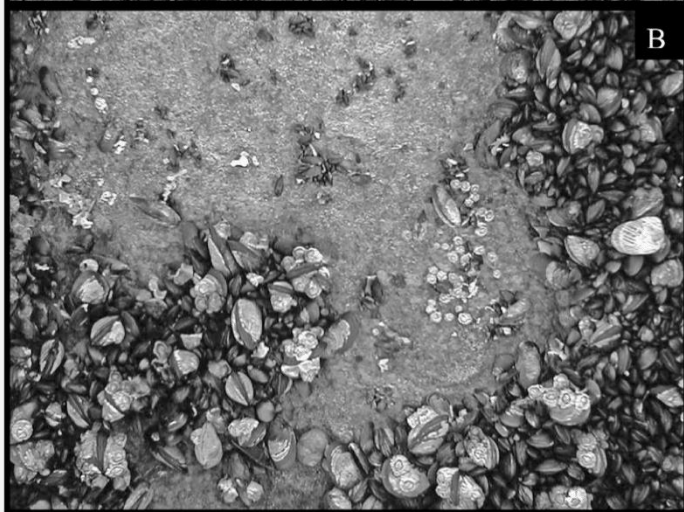


Mussel bed patch dynamics under natural conditions

Wave dislodgment



A



B

Carrington et al., 2009

Predation pressure

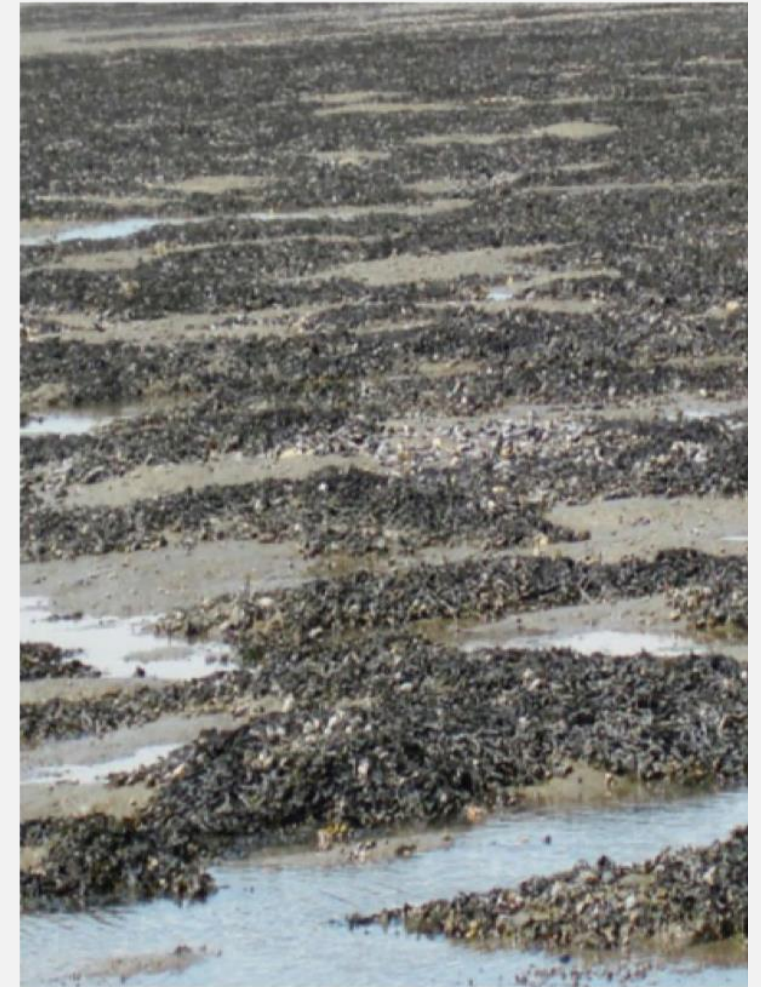


Credit Dave Cowles



Credit Luke Miller

Tidal & food flow



Liu et al., 2012

Disturbance may shape mussel distribution patterns

Scattered
pattern



Labyrinth
pattern



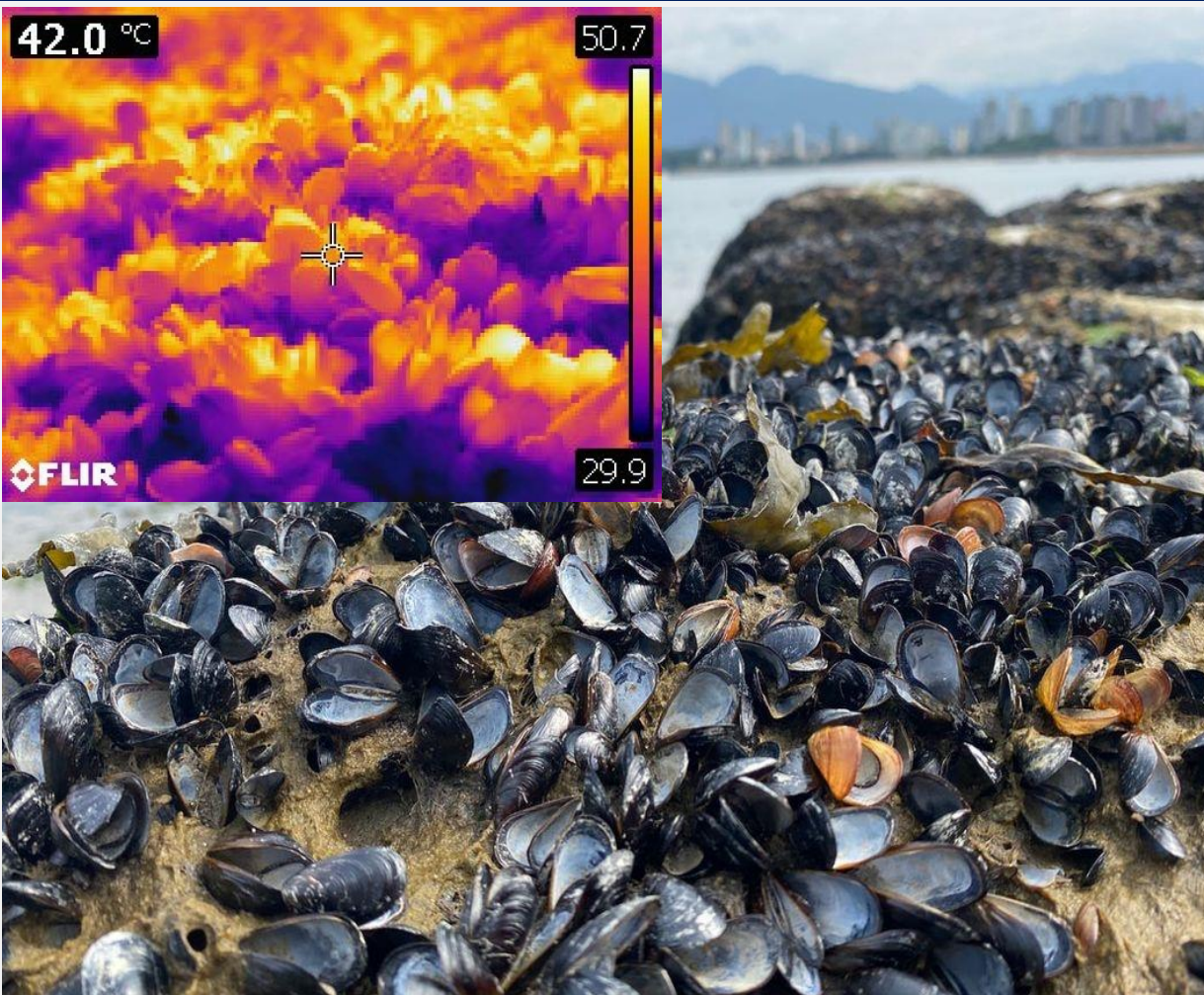
Clumps
pattern



*Assume homogenous substrate

replot from
de Jager et al., 2017

Mussel mass mortality under heat waves



More than a billion seashore animals may have cooked to death in B.C. heat wave, says UBC researcher

CBC News



This event could indicate the loss of the New Zealand green lipped mussels from their namesake country. C E Newman / Shutterstock

Half a million mussels found “Cooked to death” on a beach in New Zealand

IFLScience

'Regular' summer mortality in Hong Kong

“So far, my students and I have recorded dead animals on beaches that span hundreds of kilometers of shoreline,” he said. “Eventually, parts of the British Columbia coast may become more like **Hong Kong** and other hot parts of the world where many of the intertidal species die off every single summer.”



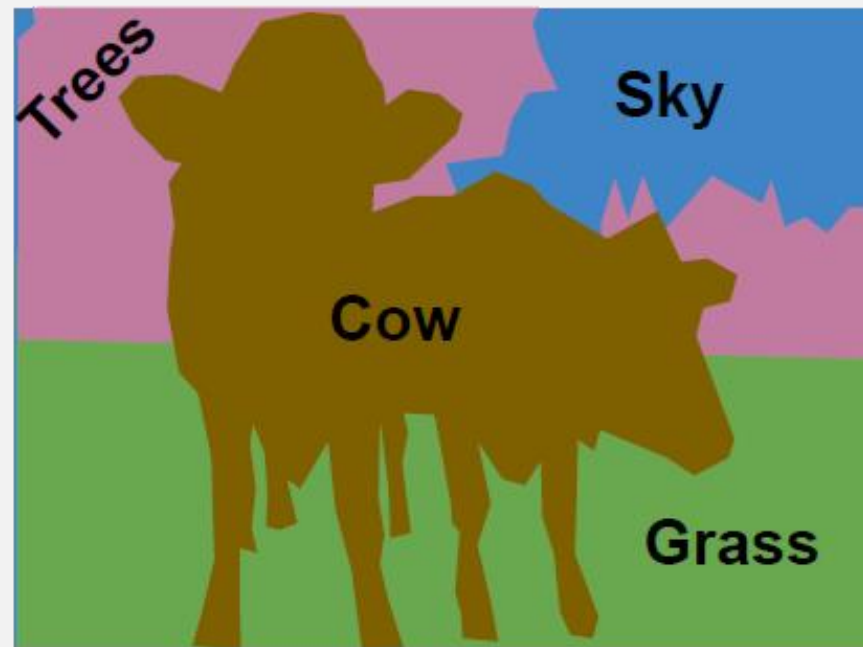
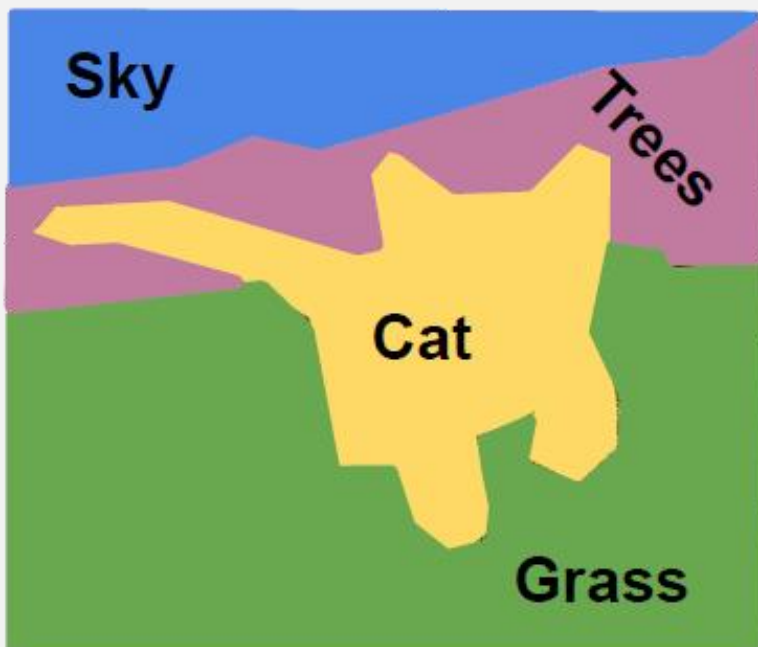
Current survey approach: transect + quadrats



Can you tell where the mussels are from field images?



Semantic segmentation: label each pixel with a category

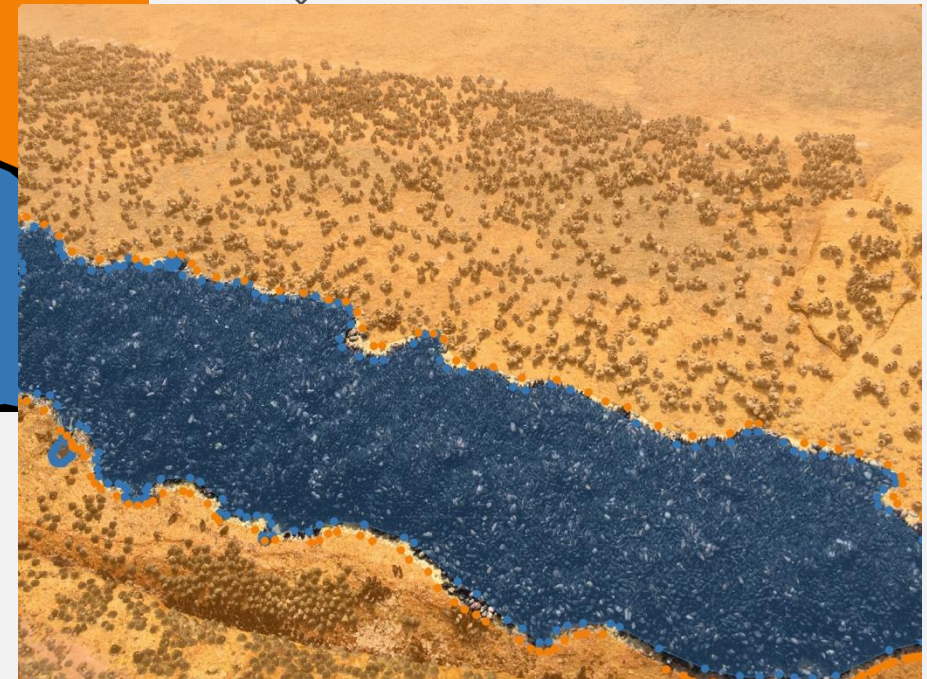
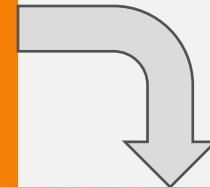
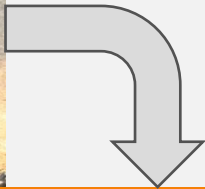
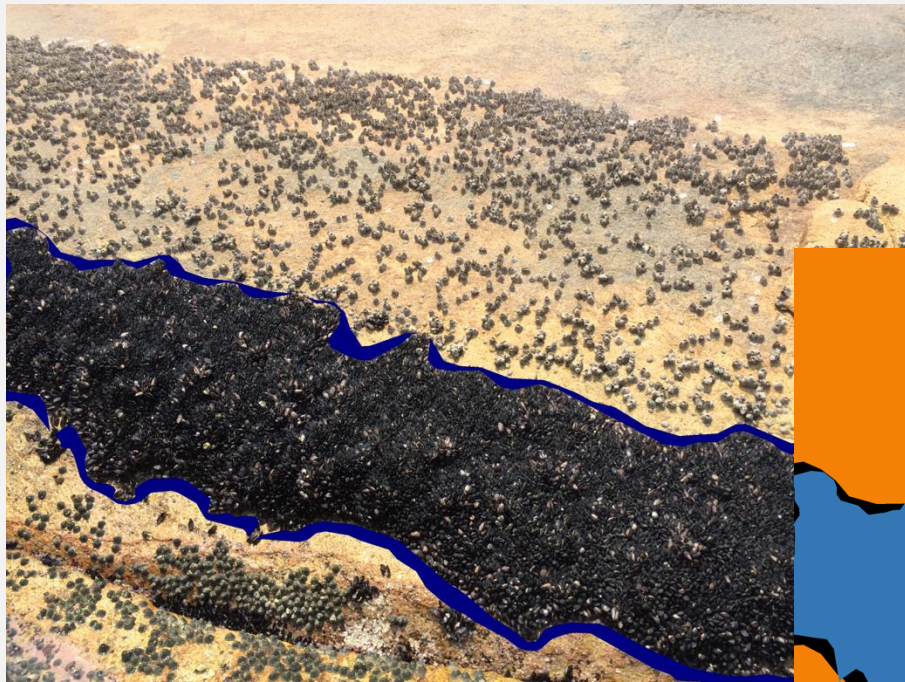


Semantic segmentation for mussel bed image analysis



Information Technology Services
The University of Hong Kong

Research Computing



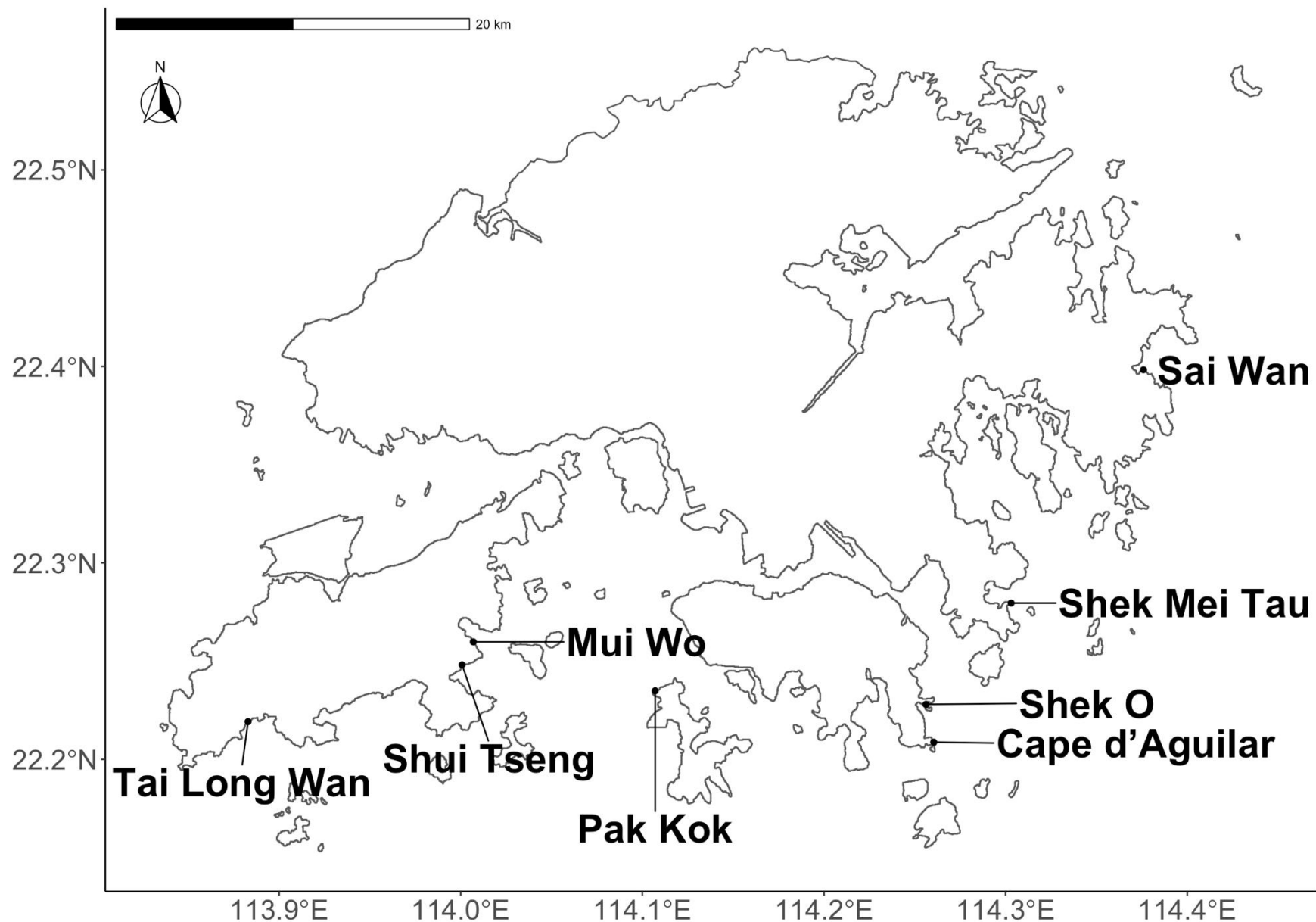
U-net: Convolutional networks for biomedical image segmentation

[O Ronneberger](#), [P Fischer](#), [T Brox](#) - ... Conference on Medical image ..., 2015 - Springer

... We demonstrate the application of the **u-net** to three different **segmentation** tasks. The first task is the **segmentation** of neuronal structures in electron microscopic recordings. An ...

☆ Save Cite Cited by 43102 Related articles All 27 versions

Photographic dataset sampling and annotation



Total 1,455
images

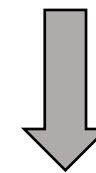
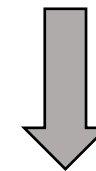


Image annotation



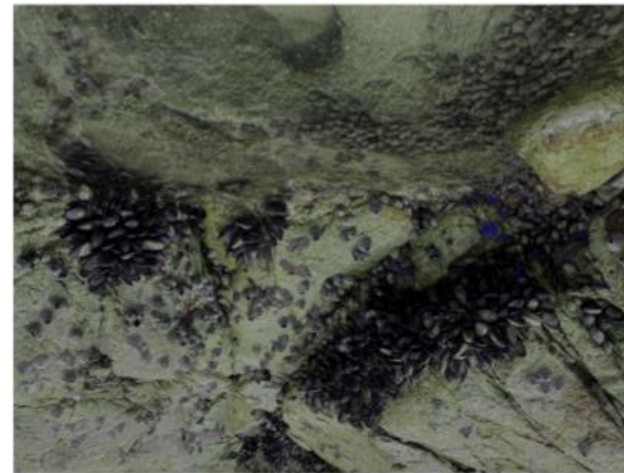
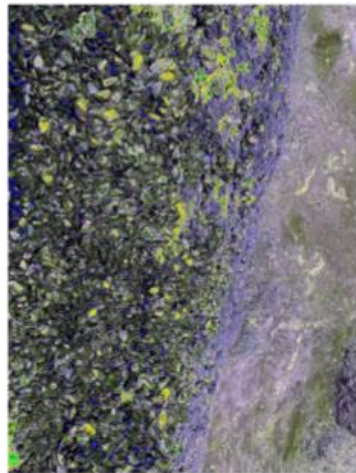
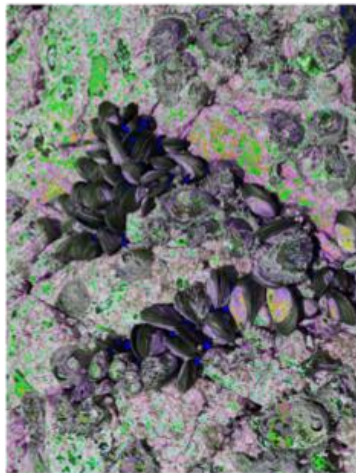
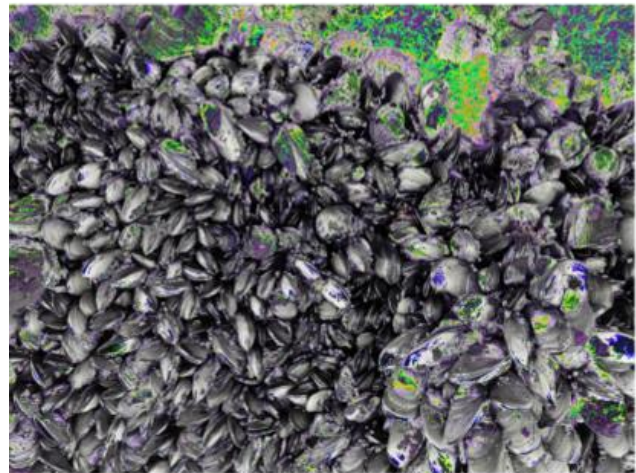
90% training
(1,309 images)

10% validation
(146 images)

Image augmentation to improve data quality



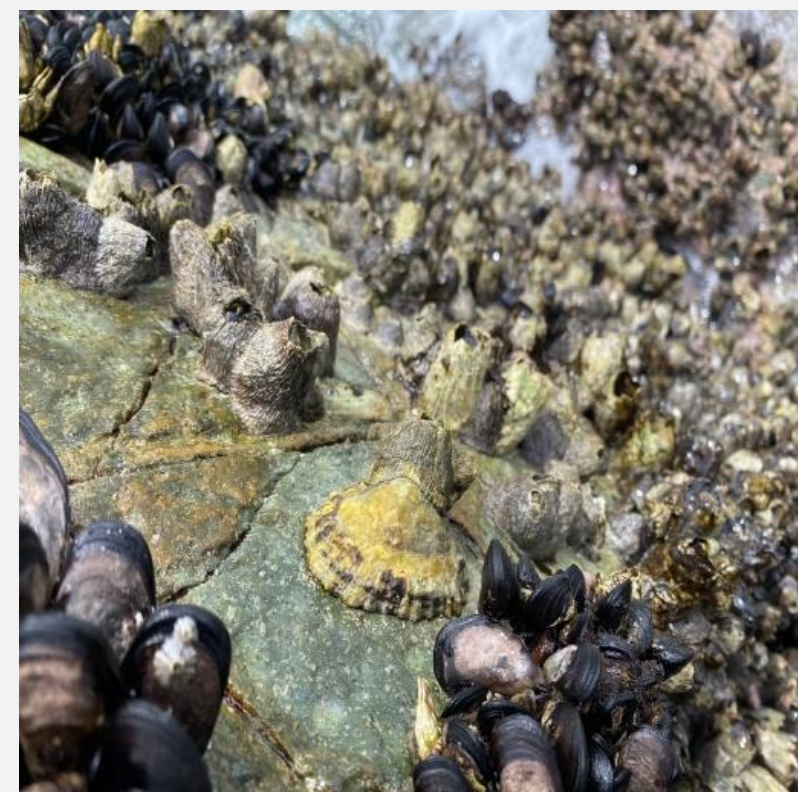
Raw images



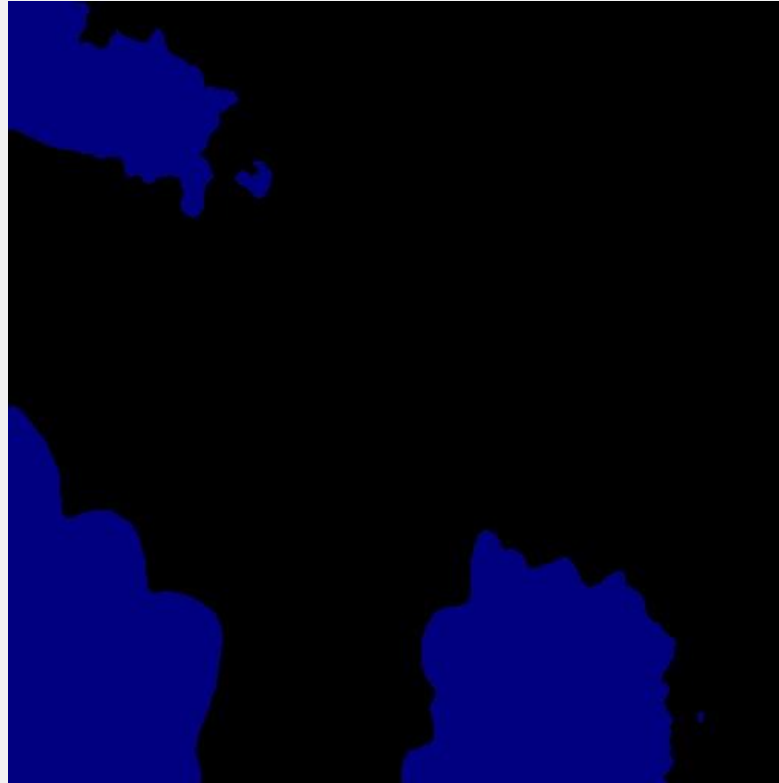
Augmented images

Random flip; random adjust image brightness, contrast, saturation, hue

Close-range: ~10-25 cm taken by phone (>92% accuracy)



Resized input



Predicted output

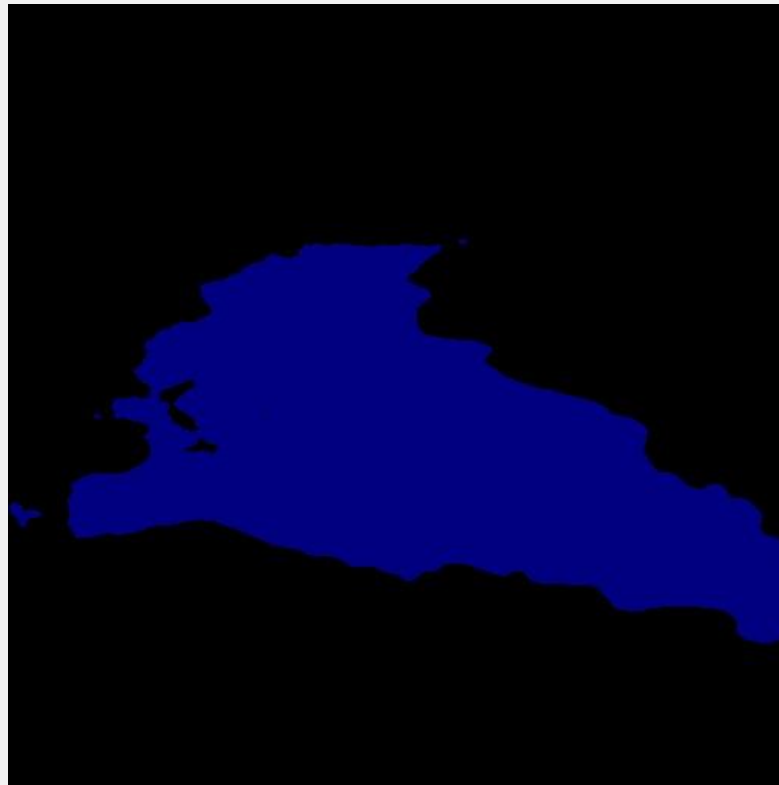


Overlay

Mid-range: ~100-200 cm taken by phone (>92% accuracy)



Resized input

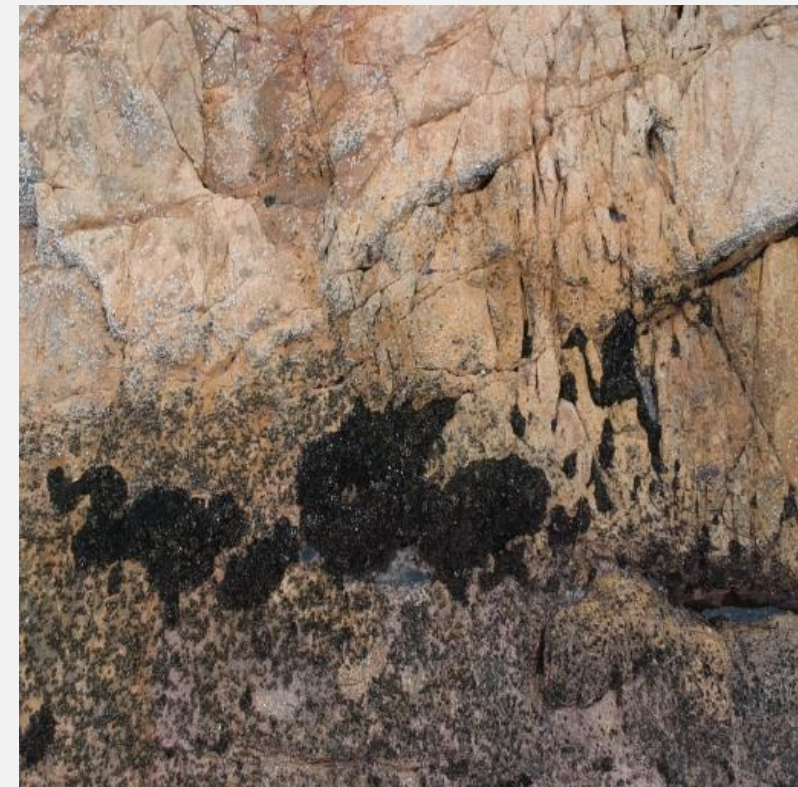


Predicted output

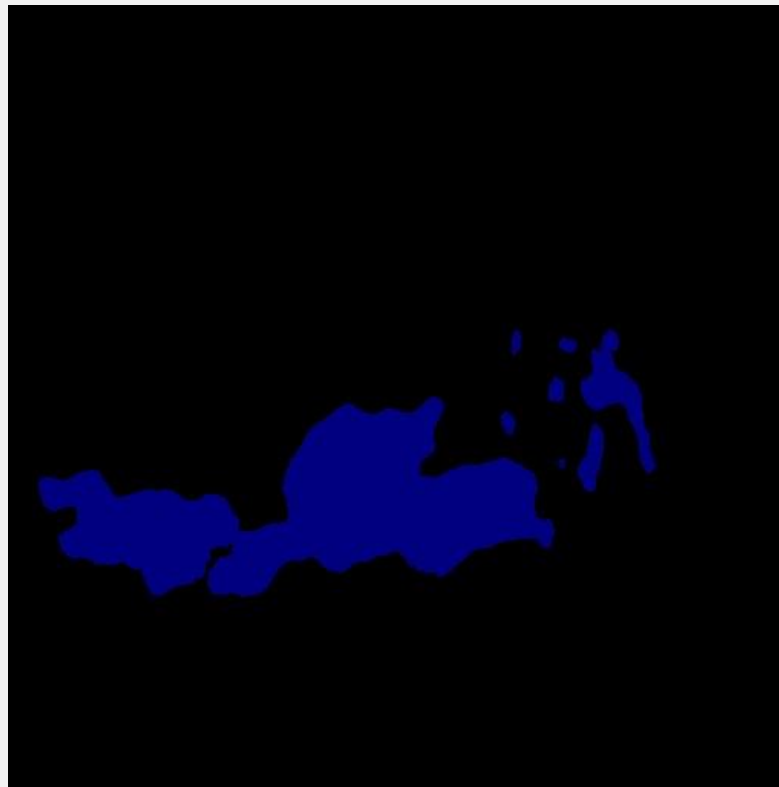


Overlay

Long-range: ~500-700 cm taken by drone (>92% accuracy)



Resized input

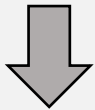
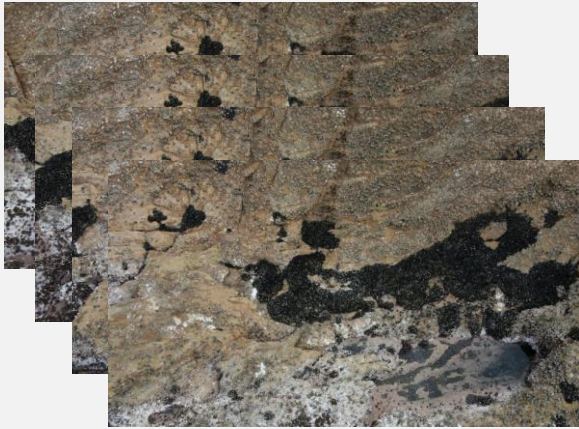
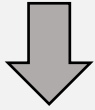


Predicted output

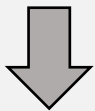


Overlay

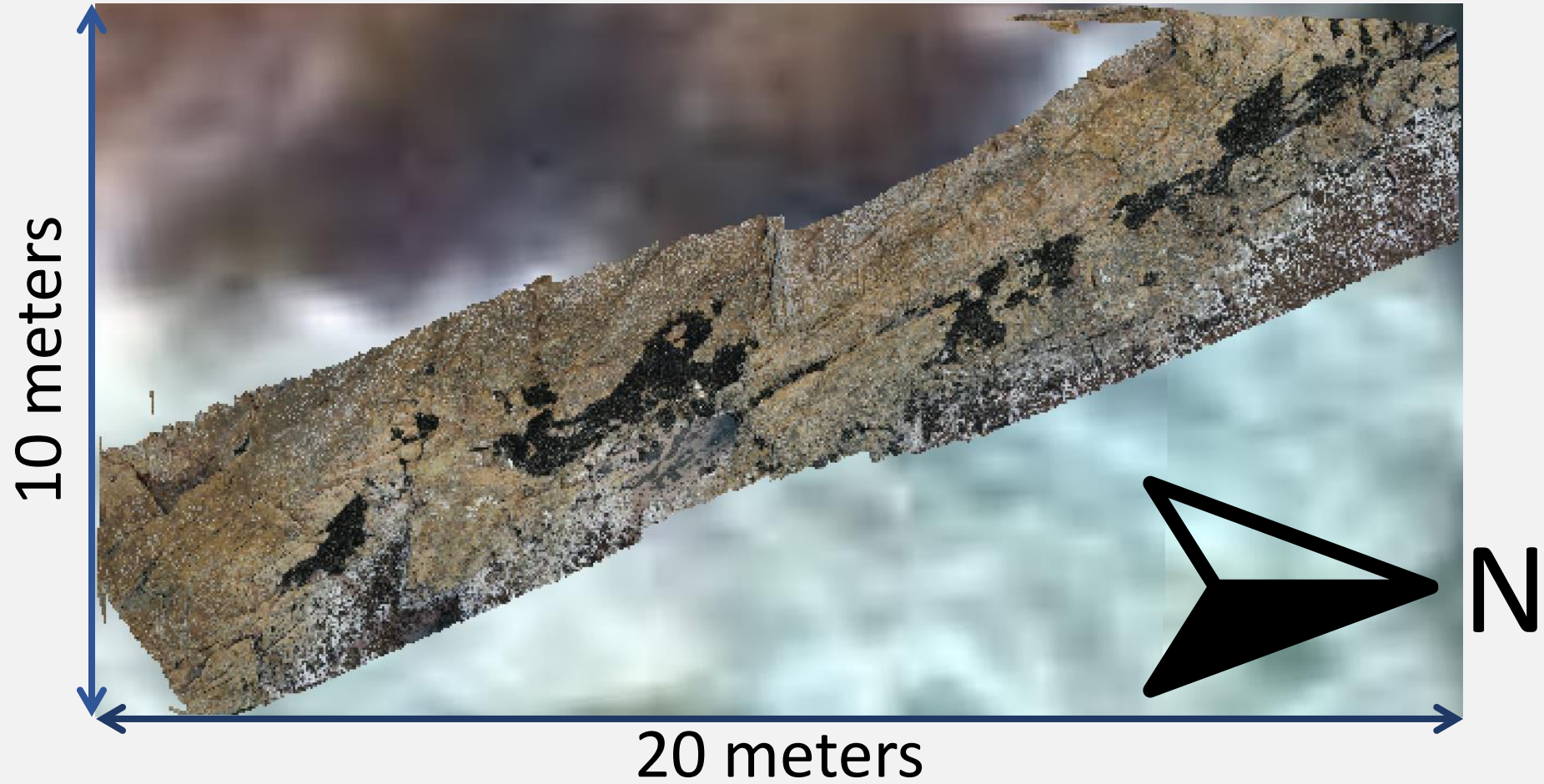
UAVs based mussel bed monitoring & quantification



SfM



Orthophoto



Gu et al., in prep.

Semantic segmentation reveal mussel bed patch dynamics



July segment sample



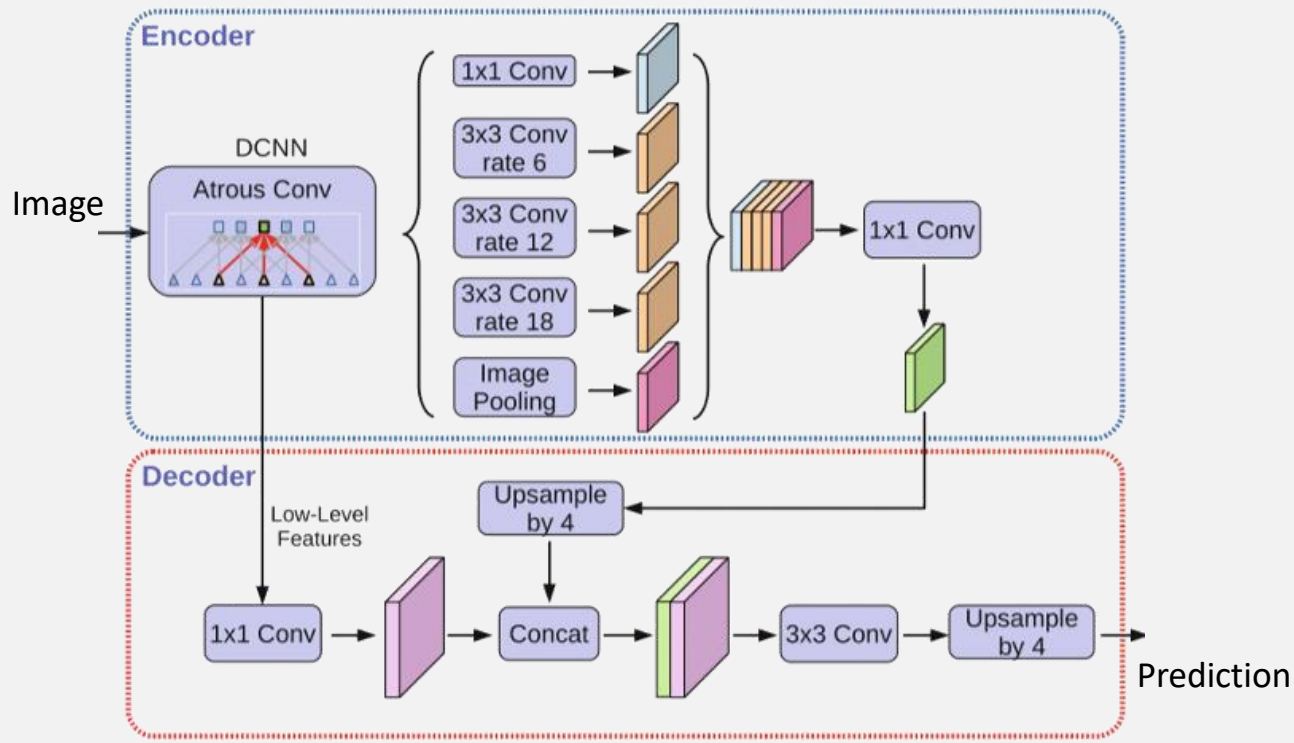
5.3 m² of mussel lost within one month (shrink 2% over 230 m²)



August segment sample

Gu et al., in prep.

CNN based semantic segmentation for intertidal mussels



Yi-Fei Gu

Thermal ecology
Remote sensing
Computer vision

Scale-up

Gu et al., 2023. Ecological Informatics (in prep.)

Acknowledgements

Postgraduate Scholarship
(PGS) HKU



Thanks!

Yi-Fei Gu

guyf0601@connect.hku.hk



Vicellken

<https://www.tidehku.com>