# ASSESSMENT OF TROPICAL BLUE CARBON RESERVES IN THAILAND

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## CERTIFICATE OF AUTHORSHIP / ORIGINALITY

I certify that the work presented in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree, except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Pemika Apichanangkool

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## PUBLICATIONS

Peer reviewed journal articles arising directly from this thesis:

**Chapter 2:**

P. Apichanangkool, P.I Macreadie, H. Kennedy, D. Herr & P.J Ralph. The Impacts of Tropical Seagrass Loss on Blue Carbon Sink Capacity. Submitted to Scientific Report.

**Chapter 3:**

P. Apichanangkool, H. Kennedy, P.I Macreadie, D. Herr & P.J Ralph. The influences of species-specific seagrass canopy structure on Blue carbon sink capacity. In preparation.

**Chapter 4:**

P. Apichanangkool, P.I Macreadie, H. Kennedy & P.J Ralph. Artificial seagrass: the alternative way of Blue Carbon restoration. In preparation.

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Tukey post hoc tests (95% confidence level). The same letters given for different treatments indicates that there was no significant difference detected (95% confidence level). Mean ± S.E.M, n=10.

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## ABBREVIATION

| | |
|---|---|
| $C_{org}$ | Organic carbon |
| df | Degrees of freedom |
| DO | Dissolved oxygen |
| GPP | Gross primary production |
| MS | Mean square |
| NCP | Net community production |
| POC | Particulate organic carbon |
| R | Respiration |
| SPM | Suspended particulate matter |

## ABSTRACT

Carbon dioxide ($CO_2$) emission through human activities is one of the most critical issues affecting the entire globe. Among the solutions, carbon sequestration is an important way to reduce atmospheric $CO_2$. Vegetated coastal habitats – seagrasses, saltmarshes, and mangroves – are among the most effective carbon sinks of the world. These habitats capture and store (sequester) large quanties of organic carbon ($C_{org}$), termed 'blue carbon'. The rapid decline of seagrass in many areas around the world, especially in Southeast Asia has motivated us to study the carbon-sink capacity of tropical Blue Carbon habitats, as well as the impact of the loss of seagrass. This study comprised of three major aims: 1) to investigate the impact of seagrass loss on blue carbon sink capacity; 2) to investigate the influence of seagrass species-specific canopy structure on blue carbon sink capacity; and 3) to investigate the feasibility of using artificial seagrass for blue carbon restoration.

Seagrass meadows at Haad Chao Mai National Park, Trang, Thailand trap allochthonous (externally-produced) carbon into sediment reaching up to 90% of $C_{org}$ stored. At a pristine meadow, seagrass densities play a major role in determining the sediment $C_{org}$ stock. Seagrass canopy height was found to be not important when comparing $C_{org}$ sink capacity between *Thalassia hemprichii* (medium-sized species) and *Enhalus acoroides* (large-sized species) in this study. On the other hand, seagrass densities influenced the trapping capacity of allochthonous carbon. The sediment

organic carbon sources of *T. hemprichii* and *E. acoroides* beds for all densities tested were similar (dominated by suspended particulate matter and mangrove for the top 15 cm of sediment). High shoot densities of seagrass could promote the settlement of suspended particles by increasing the chance of particle to contact directly with leaf blade. Seagrass biomass influenced the community metabolism. The Net Community Production (NCP) of seagrass meadows was higher with increased above-ground biomass. NCP measured in meadows with 75% cover of *T. hemprichii* (104.59 ± 21.72 mmol C $m^{-2}$ $d^{-1}$) and *E. acoroides* (166.92 ± 12.32 mmol C $m^{-2}$ $d^{-1}$) were higher than these of NCP measured in meadows with 12% cover of *T. hemprichii* (63.54 ± 5.53 mmol C $m^{-2}$ $d^{-1}$), *E. acoroides* (78.09 ± 4.63 mmol C $m^{-2}$ $d^{-1}$) and unvegetated sediment (53.36 ± 4.11 mmol C $m^{-2}$ $d^{-1}$). Seagrass loss following elevated sedimentation and increasing water turbidity lead to the loss of 89% of sediment organic carbon ($C_{org}$) stock. Loss of seagrass resulted in the loss of allochthonous carbon trapped by the seagrass canopy. Loss of seagrass also altered the sediment grain size distribution. Elevation of coarse grains was found in a denuded site compared to a pristine meadow. About 50% of sediment grain size from the pristine meadow consisted of fine sane (0.125 – 0.25 mm), while 50% of sediment from the pristien meadow consisted of very fine sane (0.0625 – 0.125 mm). The evidence of a weakened blue carbon sink due to seagrass loss was also found as a reduction of carbon sequestration. The level of Net Community Production (NCP) at a denuded site (21.13 ± 8.30 mmol C $m^{-2}$ $d^{-1}$) was lower than the NCP measured at a pristine meadow (53.36 ± 4.11 mmol C $m^{-2}$ $d^{-1}$).

While the negative impact of seagrass loss on blue carbon sink capacity was evaluated, artificial seagrass was shown to be an innovative technique to enhance particle- and organic carbon deposition. The particle deposition measured at the denuded site with artificial seagrass was 3-times higher than the particle deposition rate measured at the denuded site without artificial seagrass. The organic carbon trapped by artificial seagrass was 12-times higher than occurred at these denuded sites without artificial seagrass. There was no significant difference in the particle deposition rate and organic carbon deposition rate between an artificial seagrass experiment and the natural pristine seagrass meadows. Thus, artificial seagrass is an effective tool to recover blue carbon sink capacity where the allaochthonous carbon is a major carbon source, artificial seagrass is an effective tool in the recovery of blue carbon sink capacity – it enables a more rapid recovery and requires less effort than other restoration techniques.For better estimates of blue carbon sink capacity, seagrass abundance was recommended as an appropriate monitoring indicator because it influences the sediment $C_{org}$ stock, while species-specific canopy height did not play an important role determining sediment $C_{org}$ stock in this particular study.