Where are the Christchurch Penguins?

Aaron Shi, Josephine O'Brien, Gwinyiririrai Jachi, Myles Gentry, & Jack Evans

Cite as: Shi A, O'Brien J, Jachi G, Gentry M, and Evans J, 2025, Where are the Christchurch Penguins. A report produced as part of the GEOG309 Research for Resilient Environments and Communities course, University of Canterbury, 2025

Table of Contents

Executive summary

- Despite their ecological importance, little penguins (*Eudyptula minor*) remain largely understudied, particularly in Christchurch, New Zealand
- In New Zealand, little penguin populations are declining, and they are classified as an "At risk" species by the Department of Conservation
- This project aimed to answer several interconnected research questions:
    - Where are little penguins located in New Brighton?
    - What is threatening little penguins in New Brighton?
    - What conservation measures could be implemented to protect little penguins in New Brighton?
- Field surveys were undertaken at New Brighton Beach to identify signs of little penguin presence, which involved listening for vocalisations and looking for visual evidence such as footprints
- No evidence of a little penguin population was found in New Brighton, but multiple threats, including human and dog presence, were observed
- Given the presence of threats in the area, implementing conservation measures such as signage and fencing would help support a little penguin population in New Brighton
- Future research should involve a long-term monitoring program, and should utilise equipment such as a trail camera or audio recorder to allow for more robust data collection

Introduction

Little penguins (*Eudyptula minor*) are a species of seabird which can be found around New Zealand and southern Australia (Colombelli-Négrel & Iasiello, 2023). As an indicator species, little penguins are of critical importance to ecosystems and natural environments (Colombelli-Négrel & Iasiello, 2023). Recently, however, increased predation and human interference has resulted in the Department of Conservation (DOC) classifying little penguins as being an "At risk-declining" species (DOC, n.d.). Given that little penguins are a relatively understudied species, conducting research into little penguin populations can, therefore, provide valuable insights into their ecology and potential threats. In this project, we worked with the International Antarctic Centre to determine where little penguins are located in Christchurch, New Zealand, what is threatening them, and what conservation measures could be implemented.

Several areas within Christchurch were initially of interest to our community partner, including New Brighton Beach, Sumner Beach, and the Lyttelton Port area. Ultimately, however, a collective decision was made to focus research on the New Brighton area. Of all the potential research areas, least was known about little penguins in New Brighton, and thus this area presented the greatest research opportunities. Additionally, there were a number of little penguin sightings reported along New Brighton Beach via iNaturalist, an online community science platform (iNaturalist, n.d.). Many of the sightings were of deceased little penguins (iNaturalist, n.d.), which further indicated an opportunity to identify threats to little penguins in New Brighton, and consider conservation measures. Anecdotal evidence from our community partner also strongly suggested there was a little penguin population in the New Brighton area.

In this report, a literature review is first presented to highlight existing research on little penguins. Then, methods pertaining to both data collection and data analysis in this research project are described. Finally, results are discussed, and key limitations are identified, along with several considerations for future research.

Literature review

To aid in the investigation of our research questions, existing literature on several key themes relating to little penguins was reviewed. Understanding these themes allowed us to refine our research questions and research methodology.

Habitat and distribution

The distribution of little penguin populations is significantly influenced by the availability of suitable habitat areas (Colombelli-Négrel & Iasiello, 2023). As determined by Braidwood et al. (2011), quality habitats are important for the breeding success of little penguins. Thus, having insight into the nesting habits of little penguins is essential for conducting focused research and guiding conservation efforts. Additionally, little penguins are a philopatric species, meaning they will often return to the same nest site yearly (Braidwood et al., 2011). This further highlights the importance of understanding existing distributions of little penguin populations.

While little penguins will occupy a wide range of habitats, the most suitable nest sites are generally in areas that offer protection from both predators and inclement weather (Dann, 1994). Common examples of nest locations, therefore, include burrows in sand or soil, burrows under vegetation, rock crevices, and caves (Dann, 1994). Artificial nest boxes are also an important habitat for penguins (Dann, 1994). Dann (1994) found that little penguin populations had significantly increased in an area near Dunedin, New Zealand, after such nest boxes had been installed.

Overall, however, as found by Colombelli-Négrel and Iasiello (2023), little penguins also adapt to their environments. In the study conducted by Colombelli-Négrel and Iasiello (2023), vegetation did not impact nest usage. This, they noted, could be due to the lack of predators in the area, rather than a specific preference of little penguins.

Diet

One of the most important things that affects where little blue penguins (*Eudyptula minor*) live and how stable their populations are is what they eat. As central-place foragers, these penguins are restricted by the distance they may move from their burrows to forage. Their colonies survive only in areas with abundant high-quality prey, notably small schooling fish and squid, close to shore. When this food is scarce or moves further offshore, penguins must devote more energy to foraging, which can lead to reduced breeding success or the abandonment of colonies.

Penguins researched on Banks Peninsula, Stewart Island, and Oamaru were found to have significant changes in prey composition. Arrow squid were the most common in Banks Peninsula, although fish species such as sprat were abundant. This demonstrates both food diversity and geographical variances, which may influence colony health. Studies done on Phillip Island, Australia, highlighted the importance of seasonality, with anchovy, pilchard, and squid dominance changing during the breeding cycle. While these studies concentrate on fine-scale and periodic dietary changes, the use of stomach flushing has limitations. The strategy is obtrusive, favors prey with harder remains, and provides just a quick overview of food (Montague & Cullen, 1988).

Conservation and monitoring methods

Existing literature on the conservation of little blue penguins highlights the fact that traditional handling and tagging methods can cause physiological stress and behavioral changes that negatively affect breeding success of little penguins. Carroll et al. (2016) demonstrated that repeated capture and handling elevated corticosterone levels and aggression. This suggests that even minimal disturbance or contact can negatively stress penguins. Additionally, Larcombe (2016) found that chicks from tourist-visited colonies had significantly lower fledging weights compared to those from undisturbed colonies. This is a key example of the impacts of human disturbance on penguin colonies.

Research has investigated less invasive monitoring methods to use on little penguins in an aim to reduce stress while still being able to maintain data reliability. The New Zealand Penguin Initiative (2024) reports a three-tier strategy that ranges from intensive methods, such as microchip-based monitoring, to more low impact approaches using trail cameras, footprint surveys, and acoustic recorders. Colombelli-Négrel (2023) found that automated acoustic recorders can estimate population size with reasonable accuracy while avoiding the negative effects of handling, although trained observers were still found to detect more calls. These methods are particularly important for unmonitored or newly identified colonies such as the penguins at New Brighton beach where penguin presence is uncertain. Also, ethical considerations restrict us from using any overly intrusive methods.

In addition to different monitoring techniques, the literature identifies several human-related threats that have negative impacts on little penguins. Costello and Colombelli-Négrel (2023) observed that the presence of dogs and the use of white lights at night delayed penguins' return

from the sea and increased vocalisation rates which are clear indicators of penguin stress. These findings highlight the vulnerability of penguins at the borderline between urban areas and coastal habitats, and the need for low impact conservation strategies focused on habitat protection as well as public awareness and non-invasive monitoring methods.

Threats and challenges

Little penguins face several threats that affect both their survival and reproduction. Blamey et al. (2024) delves into domestic dog attacks and their effects on penguin colonies. Off leash dogs pose a serious threat through physical trauma. Key findings highlighted extinction risks beyond 10% for small colonies using a Leslie matrix model. Additionally, terrestrial predators including stoats, ferrets and hedgehogs consume penguin eggs, hindering reproduction during breeding seasons. This study's scope is limited to recorded penguin fatalities; dog presence insights are ignored. Furthermore, several mitigation strategies are mentioned, such as fencing, but feasibility in terms of costing is not evaluated. The idea of habitat fragmentation from fencing is not developed; little penguins may be unable to access ideal nesting spots.

Larcombe (2016) explores the impact of human disturbance on little penguin behavioral responses. Heart rate monitoring via artificial eggs and corticosterone sampling indicated that female penguins had consistently higher heart rates than males when approached. Furthermore, chicks present in colonies exposed to tourists displayed significantly lower bodyweight compared to the control colony, suggesting that long-term survival is a concern.

Costello and Colombelli-Négrel (2023) investigate how nocturnal human activity affects little penguins using various methods including surveys, acoustic monitoring, and infrared cameras.

Key findings suggest that little penguins tend to delay returning from the sea when dogs and human disturbances are present. Furthermore, COVID-19 regulations and the emittance of white light during the night increased from 20% to 64%, significantly impacting the penguins and thus producing later nesting times.

Human-related impacts include litter, which degrades nesting areas and poses ingestion and entanglement risks. Additionally, little penguins are particularly vulnerable to vehicle and boat strikes, which increase mortality.

Methods

To conduct this research, footprint surveys and vocalisation surveys for little penguin calls were used. Research was done on the established site/section of the beach being investigated in New Brighton, during sunrise and sunset, as this is when the little penguins are most active. Upon arrival at the beach, researchers walked along the beach shore and dunes for approximately an hour, looking for footprints and listening for bird calls.

Any footprints were to be tallied and recorded if they were identified to be a footprint of a little penguin. If a footprint was found, photos were taken and the exact coordinates that the footprints were found were also recorded.

Additionally, researchers listened out for any little penguin calls from juveniles or adults. If heard, these were also recorded and tallied along with the coordinates of where the call was observed. When possible, an audio recording of the penguin call would also be captured. If other potential threats were seen, such as dog faeces and litter, these were also recorded.

As it is dark during survey times, torches were used to get a better observation of the beach and high visibility vests were worn to ensure the safety of the researchers.

The surveys and audio detection should be conducted multiple times over a long period of time in order to sufficiently track any signs of little penguins and/or potential threats.

Results and Discussion

Between the 13th of August and 27th of September 2025 our group carried out nine one-to-two-hour surveys in the New Brighton Beach area in order to identify any evidence of little blue penguin presence and to assess potential threats facing them. The surveys were undertaken either before sunrise or after sunset along the foredunes and upper dune walking tracks. Our group's observations were recorded, which included any visual or audio indications of penguin activity such as footprints, faeces, burrows, or calls. The full record of our observations and site details is presented in Table 1, which summarizes the date, time, coordinates, and field notes for each of our surveys.

Table 1

Field Research Observations

Date:	Time:	Coordinates:	Penguin spotted (Y/N):	Vocalization heard (Y/N):	Footprints observed (Y/N):	Faeces Observed (Y/N):	Threats:	Notes:
13/08/25	06:00	-43.486297, 172.723526	N	N	N	Y	Dog seen in dunes, glass bottles found near potential burrow	Walked for an hour along the dunes, found no footprints/vocalizations but observed dog faeces on the beach.
22/08/25	18:00		N	N	N	Y		
16/09/25	18:30		N	N	N	Y		
17/09/25	18:30		N	N	N	Y		
19/09/25	18:30		N	N	N	Y		
23/09/25	18:30		N	N	N	Y		
24/09/25	18:30		N	N	N	Y		
25/09/25	19:00		N	N	N	Y		
27/09/27	19:00		N	N	N	Y		

No penguins, chicks, or active burrows were detected during the survey period, and no vocalizations were heard that could confirm current penguin presence in the area. Despite this absence of direct evidence, we found several threats that were consistently observed that would have implications for penguin habitat suitability. Dog faeces and tracks were often seen in the dune system. This indicates the frequent use of the area by dog walkers and off leash dogs. Various hazards including exposed fencing wire, glass bottles, and general litter were also found throughout the foredunes, creating potential risks of entanglement or injury to any wildlife present in the area. Furthermore, continuous human presence along the beach and walking tracks as well as bright white lighting from adjacent residential houses and streetlights suggests that disturbance pressures in the area are high and could potentially discourage penguin nesting.

Although no penguins were observed during this investigation, previous records and iNaturalist data document both deceased individuals and historical evidence of chicks within the wider New Brighton area. These prior findings indicate that penguins have previously attempted to nest along this coastline, but the current occupancy appears absent or minimal. Environmental factors such as survey timing outside the peak breeding season and weather conditions such as strong winds that hindered auditory detection and stopped us from being able to partake in surveys likely reduced the probability of confirming penguin activity. With all these factors considered, the results recorded in Table 1 provide an important baseline for understanding the environmental pressures present at New Brighton and will support the design of future monitoring methods based around the new Brighton penguin population.

Limitations

While our research on the distribution of little blue penguins in Christchurch provided some useful insights, multiple limitations restricted the extent and accuracy of our findings. Recognizing these restrictions is critical for contextualizing our findings and planning future fieldwork.

Coastal weather fluctuation was one of the most difficult issues. Strong winds and rain frequently overpowered potential penguin vocalizations, which were an important detection cue during dawn and dusk surveys. Poor weather was also quite restrictive, as we could not safely conduct or carry out surveys if the weather was considered risky.

Poor visibility due to low light made it difficult to identify any penguins coming ashore, therefore making light management another consideration. White artificial light is known to be disruptive to nocturnal seabirds, perhaps confusing or changing their activity. In order to overcome this, our group planned to employ limited lighting, relying on red torches or natural moonlight. Although this strategy was ethical and non-invasive, it diminished visual clarity, potentially causing us to miss penguins moving further away or staying low to the ground.

The semester timeframe presented us with a few logistical constraints. Securing approval and acquiring appropriate permissions from the University and Christchurch City Council to conduct bird monitoring slowed the start of fieldwork, reducing the number of possible surveys. Due to administrative restrictions and the necessity to comply to ethical research standards, certain planned tasks were unable to be accomplished within the time constraints. These restrictions limited both data volume and consistency.

Our field surveys were conducted outside of the prime breeding season, when penguin movements are less predictable. During breeding, penguins frequently wander between the water and burrows, making detection easier. Outside of this time frame, foraging and sleeping habits are more erratic, particularly among newly established colonies, meaning that this most certainly reduced detection rates, limiting the generalisability of our findings.

Fieldwork was limited only to easily accessible areas of the New Brighton coastline. Due to geographical and time constraints, other potentially appropriate penguin habitats along the Christchurch shore were not able to be monitored. While focusing on a single site enhanced our data consistency, it also limited our ability to compare colony behavior across various environments.

Recommendations for future monitoring methods

To effectively monitor little penguins in future research, three non-invasive methods are suggested: red light torches, acoustic monitoring, and trail cameras. When monitoring little penguins at dusk or dawn, the use of gentle red-light torches would be beneficial. Little penguins' habitat tends to be bluer and greener in coloration (Hadden et al., 2023). As a result, little penguins' eyes are adapted to have more functional S-cones and M-cones while lacking functional L-cones (Emerling, 2018). This is due to the absence of red coloration in their habitat. Therefore, the proposed use of red-light torches would be minimally invasive, reducing stress. This is significant because increased cortisol levels are linked to reduced breeding success (Larcombe, 2016).

Acoustic monitoring in the form of audio recorders would allow for data on penguin vocalizations and breeding activity. Little penguins are a shy and nocturnal species, therefore, passive acoustic monitoring allows for minimal intrusion (Wrege et al., 2017). Data on relative population size and terrestrial predators can be collected, providing presence information and insights into required mitigation methods. Furthermore, it is a relatively cost-effective method. However, for our project, there was difficulty obtaining consent within the given timeframe. Adequate time for consent to be approved would be beneficial.

Strategically placing trail cameras near burrows would allow for visual data collection on behavior and activity patterns. Trail cameras with infrared motion sensing technology would be the most beneficial to reduce the amount of required footage (Surmacki & Podkowa, 2022). However, these can be relatively expensive for a student-led project. Furthermore, this method involves consent requirements as New Brighton Beach is a public space.

Recommendations for threat mitigation strategies

While insufficient results were obtained in this study, a high volume of potential threats were identified. For example, litter and dog faeces were sighted during field activity indicating anthropogenic and predator presence. Litter degrades nesting areas and poses ingestion and entanglement risks. Furthermore, human disturbance impacts penguin behavioral response; it may be beneficial to implement mitigation methods if penguins are sighted (Costello & Colombelli-Négrel, 2023). Implementing visible signage near suspected colony areas would likely reduce anthropogenic activity at the site. This would reduce stress on little penguins and

potentially increase survival rates. Signage may also deter dog owners from the site and reduce terrestrial predator impact in the area.

Another mitigation strategy is the usage of fencing. Fencing provides physical barriers to both terrestrial predators and humans for penguin colonies. According to Blamey et al. (2024), domestic dog attacks posed extinction rates greater than 10% on penguins. Furthermore, dogs can pose significant physical and psychological threats to penguins through increased cortisol and physical trauma. Fencing would likely reduce these fatalities as the site becomes inaccessible to these terrestrial predators. The West Coast Penguin Trust implemented black geosynthetic mesh fencing at Pahautane (West Coast Penguin Trust, n.d.). Geosynthetic mesh fencing is not too rigid, which allows it to encase areas of varying shapes. However, the gaps in the fencing are not large enough for large predators, like dogs, to enter and penguins to escape. This reduces fatalities rates as predator entrance is blocked, and penguins cannot reach roads preventing vehicle strikes (Costello & Colombelli-Négrel, 2023). Therefore, this fencing type may be beneficial to implement at New Brighton beach if penguin presence is found.

From a long-term perspective, climate change mitigation strategies are significantly prevalent. Climate change poses implication to little penguins as it can reduce food availability, breeding success and overall survival (Dann & Chambers, 2013). This is through major implications like sea level rise, ocean acidification, and increased extreme weather events. Strategies like colony relocation may be required in the future as areas become affected. However, this poses potential for maladaptation, thus a dynamic adaptation plan would be necessary.

Conclusion

Overall, we found that there are a range of different threats on New Brighton Beach that the little penguins face, the biggest threats being human activity and predation from dogs. These threats can have a significant impact on little penguin population numbers as they are facing physical trauma from attacks and provides additional pressures on nesting success. Because of this, monitoring and mitigation efforts are needed to protect the little penguin colony present on the beach.

Mitigation efforts such as visible signage and adequate fencing will be the most effective in the protection of the little penguin colony. These efforts won't completely eradicate but will reduce the amount of disturbance the little penguins face as the dunes are their natural habitat. Furthermore, policies should be implemented to ensure the protection of the little penguin colony from any disturbance by humans and dogs. This would include rules that would prevent dogs and humans from freely roaming through the dunes, as if followed then the potential risk of a burrow collapsing or little penguin facing physical trauma from attacks is completely eradicated.

To provide more information and reliable data we would need a longer timeframe and more equipment. This study was done in a short amount of time, with minimal equipment, making it hard to conduct our observations.

A longer timeframe would allow us to go out into the field more often, increasing the chances of getting more accurate and precise data that would provide a good representation of the real little penguin population numbers.

Additionally, by doing a long-term monitoring program we would be able to see how the little penguin population numbers change over time. This is important as it allows us to measure

whether the conservations efforts that are put in place are helping sustain and grow the little penguin population numbers or if more efforts should be put in place to protect and grow the population.

Equipment such as audio recorders and trail cameras would help us pick up on signs of penguins that we may miss with our own eyes and ears. This would provide us with more reliable data as it would eliminate some of the human error that may occur when doing our observations. This equipment can be used throughout the day, even when we are not present on the site. This means that during dusk and dawn, we will be able to set up the camera and audio recorders and record sightings that we would have previously missed due to the absence of researchers.

Future research on other factors, not only population numbers, can also be beneficial in the efforts to protect the little penguin colony.

Once recording the presence of little penguins, researching and monitoring their health and behaviour can help us provide the populations with better conditions to live in which would in turn increase the survival rate of the little penguins and increase the colony population number.

Furthermore, investigating other potential threats such as the ecological pressures that little penguins are facing can help in the conservation of the penguins, as we would be able to see any future or underlying threats such as rising sea levels and coastal erosion. Understanding the ecological processes happening specifically to New Brighton can be a major step in attempts to protect the little penguin.

Many of these ideas and methods require permission and permits from the governing bodies such as the Christchurch City Council. This is needed to ensure that the practices carried out are both ethical and legal. This means that any monitoring methods executed are not causing any harm or

disturbance to the little penguins and their environment, whilst also abiding to animal and environmental laws.

Acknowledgements

The group would like to thank Annabel Keys at the International Antarctic Centre, our community partner. Special thanks to our tutor, Megan Reaves, for assisting with group meetings and patiently answering our questions. Her feedback was very helpful. We are also grateful to Melissa McLuskie from the New Zealand Penguin Initiative (NZPI) for sharing her knowledge with the group. Her contribution helped our understanding of the project.

References

Barreau, E., Kato, A., Chiaradia, A., & Ropert-Coudert, Y. (2021). The consequences of chaos: Foraging activity of a marine predator remains impacted several days after the end of a storm. *PLOS ONE*, *16*(7), e0254269. https://doi.org/10.1371/journal.pone.0254269

Blamey, L. K., Bulman, C. M., Tuck, G. N., Woehler, E. J., Marker, P. F., & Patterson, T. A. (2024). Evaluating risks to seabirds on the urban–coastal interface: Modelling dog attacks on little penguin populations in Tasmania. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *34*(3), e4113. https://onlinelibrary.wiley.com/doi/abs/10.1002/aqc.4113

Braidwood, J., Kunz, J., & Wilson, K. -J. (2011). Effect of habitat features on the breeding success of the blue penguin (Eudyptula minor) on the West Coast of New Zealand. *New Zealand Journal of Zoology*, *38*(2), 131–141. https://doi.org/10.1080/03014223.2010.535498

Carroll, G., Turner, E., Dann, P., & Harcourt, R. (2016). Prior exposure to capture heightens the corticosterone and behavioural responses of little penguins (Eudyptula minor) to acute stress. *Conservation Physiology*, *4*(1), cov061. https://doi.org/10.1093/conphys/cov061

Colombelli-Négrel, D., & Iasiello, L. (2023). The importance of fine-scale landscape characteristics for habitat selection in penguins. *Biodiversity and Conservation*, *32*, 1369–1401. https://doi.org/10.1007/s10531-023-02557-3

Costello, E. C., & Colombelli-Négrel, D. (2023). Human activities at night negatively impact Little Penguin (Eudyptula minor) numbers and behaviours. *Ibis*, *165*(4), 1378–1396. https://onlinelibrary.wiley.com/doi/abs/10.1111/ibi.13217

Dann, P. (1994). The abundance, breeding distribution and nest sites of blue penguins in Otago, New Zealand. *Notornis*, *41*(3), 157–166. https://doi.org/10.63172/735213fnikax

Dann, P., & Chambers, L. (2013). Ecological effects of climate change on little penguins Eudyptula minor and the potential economic impact on tourism. *Climate Research*, *58*(1), 67–79. https://www.int-res.com/abstracts/cr/v58/n1/p67-79/

Department of Conservation. (n.d.). *Little penguin/kororā*. https://www.doc.govt.nz/nature/native-animals/birds/birds-a-z/penguins/little-penguin-korora/

Emerling, C. A. (2018). Independent pseudogenization of CYP2J19 in penguins, owls and kiwis implicates gene in red carotenoid synthesis. *Molecular phylogenetics and evolution*, *118*, 47–53. https://www.sciencedirect.com/science/article/pii/S1055790317302427

Hadden, P. W., Vorobyev, M., Hadden, W. H., Bonadonna, F., McGhee, C. N., & Zhang, J. (2023). Can penguins (Spheniscidae) see in the ultraviolet spectrum?. *Polar Biology*, *46*(10), 1111–1121. https://link.springer.com/article/10.1007/s00300-023-03188-8

iNaturalist. (n.d.). *Observations*. Retrieved September 24, 2025, from https://www.inaturalist.org/observations?subview=map&taxon_id=3817

Larcombe, S. (2016). *Little penguins (Eudyptula minor) and human disturbance* (Doctoral dissertation, University of Otago).

https://ourarchive.otago.ac.nz/esploro/outputs/graduate/Little-Penguins-Eudyptula-minor-and-Human/9926478189701891

Montague, T. L., & Cullen, J. M. (1988). The diet of the little penguin (*Eudyptula minor*) at Phillip Island, Victoria. *Emu – Austral Ornithology, 88*(3), 138–149. https://doi.org/10.1071/MU9880138

New Zealand Penguin Initiative. (2024). *Kororā monitoring protocols* (Version 5). https://www.nzpi.nz

Surmacki, A., & Podkowa, P. (2022). The use of trail cameras to monitor species inhabiting artificial nest boxes. *Ecology and Evolution*, *12*(2), e8550. https://doi.org/10.1002/ece3.8550

West Coast Penguin Trust. (n.d.). *Pahautane Penguin Fence.* https://www.westcoastpenguintrust.org.nz/projects/pahautane-penguin-fence/

Wrege, P. H., Rowland, E. D., Keen, S., & Shiu, Y. (2017). Acoustic monitoring for conservation in tropical forests: examples from forest elephants. *Methods in Ecology and Evolution*, *8*(10), 1292–1301. https://besjournals.onlinelibrary.wiley.com/doi/abs/10.1111/2041-210X.12730