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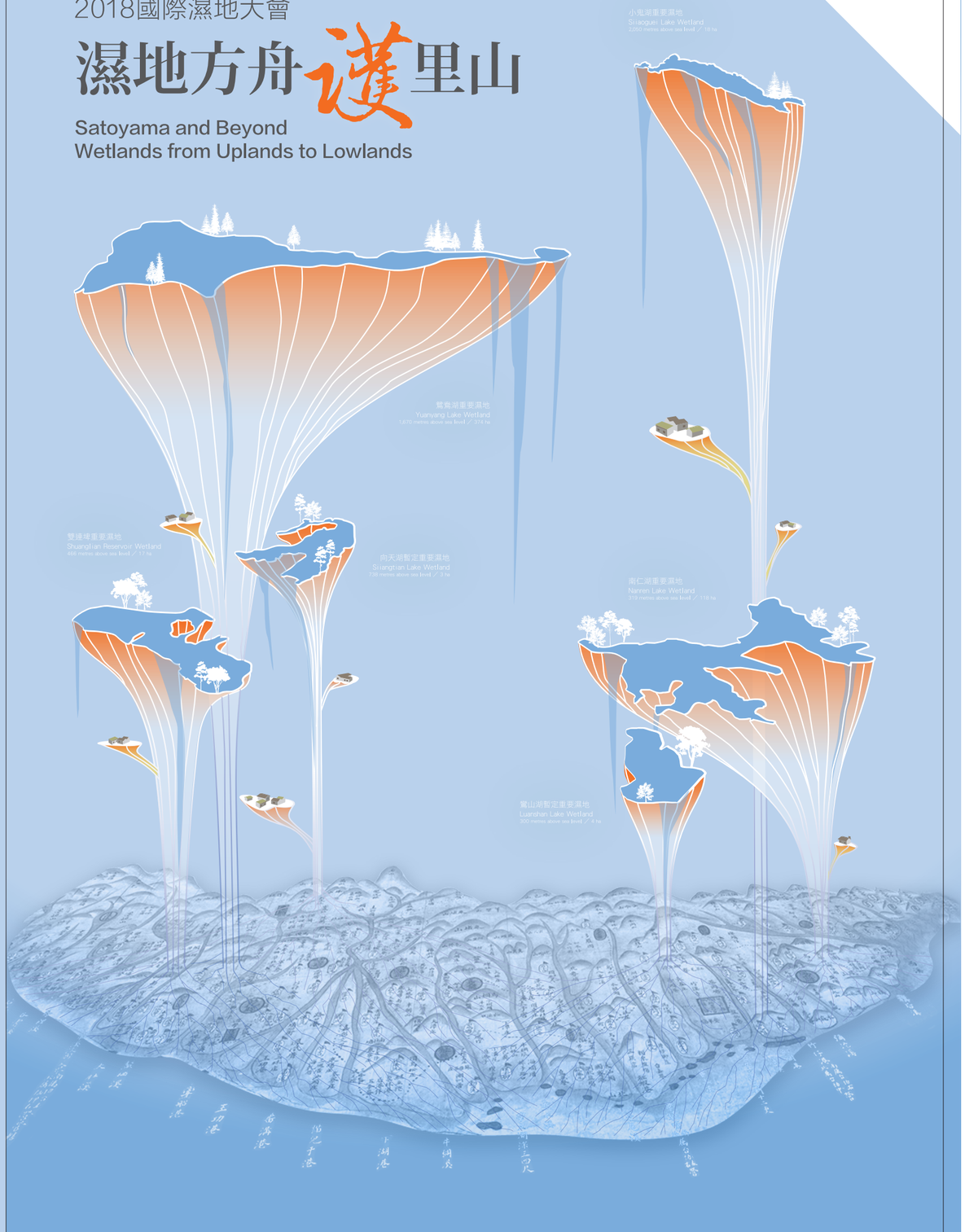

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道法自然，落實護生為重的安康之家

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摘要

所有生命都在太陽與地球交互作用之下演化出來的，大家都是太陽之子。人類長期觀察大自然的運作，發展出如老子一般強調上善若水的生態智慧，讓自己和其他群體能夠道法自然而生存。當今怎麼獲得最有利於可持續生存的生態智慧呢？

在自然叢林法則裡，人類有個體大、數量多、能夠說故事而合作；並能操作大自然，趨吉避凶，並有效的使用動植物及其它自然資源；人類耗用資源的方式，實與盜伐自然無異。人類文明興盛不過一萬多年，繁衍族群，擴展地盤，成了地球上最關鍵的物種。人類順著這個方向繼續發展，沒有體認到地球資源的有限性，更沒有考慮已傷害了其他生命，處處以大為榮。這個渴望大症使人類追求最大的城市，最高的建築物，最大的產業。現今地球已經超載，嚴重危害大自然。人類這些眾多的有利自身發展的特質發揮過頭反而是演化上的致命因素。正如英國皇家院士 Ehrlich (2013)指出全球文明崩解的三大原因：人口過多；消耗過量資源；眾多不利於環境的科技發展。如果不改正方向，往安康之家推動 ，再怎麼努力地追求發展也是枉然。

安康之家的推動要把三者視為一個不可分割的整體，從道法自然跟 盜伐自然兩個面向， 找到生活的準則。前一個是正面的，或者稱為陽；後者為負面的，可稱為陰。 要像太陽一樣，正面的貢獻出能量來，照顧好其他的生命，從事護生，也就是做好生態環境保護。而盜伐自然方面就要盡量的節儉、省用、自律。以自律利他，教化大家，保護眾生，達成生態文明。 我們擴充護生的心胸，仍然是人類往「大」的方向演化進展。

為了達到安康生活一定要教育大眾接近大自然，深入認識、體驗到生命、環境跟自己的生命價值的關聯性。最後要培養出愛護生態為出發點的企業人士，達成經濟發展與保護環境的雙贏。

關鍵詞：自律，勤儉，里山，護生

IMITATION OF NATURE: A WELLBEING COMMUNITY FOUNDED ON PROTECTION OF ALL LIVING CREATURES

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Abstract: All beings are evolved under the interactions of Sun with Earth, thus they are all the sons of Sun. Humans derive wisdom from observing and adopting the rules of nature. The best survival wisdom is like Laozi's experience in water. He emphasized and symbolized water with a supereminent virtue. How to gain eco-wisdom that sustains man-kind's development today? Struggling to survive in jungles, human-being has the advantages of being with large body size, abundant populations and abilities to create stories. Therefore, they enable to call for cooperation for manipulating nature to pursuing good fortune and avoiding natural disasters. The ways they exploit natural resources with no limitation and no regulation behave like robbers and thieves who grab goods from nature. Within less than 10 thousand years' civilization, humans become the key-stone species. Humans are anxious in building their own largest kingdom, such as mega city, the tallest building, and the largest enterprise. The syndrome which wants to become bigger and bigger has driven humans to ignore continuously diminished natural resources, in turn, has destroyed many other living creatures. Those notorious characteristics making humans' success in ruling earth planet happen to strangle themselves in the evolutionary long run. If humans do not change the current development mode to a modest one, then humans will not succeed, despite of hard-working. With respect to promote a wellbeing society at the modest level, the body-mind-spirit triplet of a man-kind should be taken indivisibly. Arriving at the turning point, man-kinds have to use their wisdom to search and lay out living guidelines from the two ends, both imitating the nature and robing the nature. The former approach is positive, or so called yang in Chinese. Yang like the Sun cares about and guards all creatures. In contrast, the latter approach is negative, yin. Yin fosters the merits which adopt a thrifty and simple life with less expenditure and little waste. Spiritually, man-kinds should be self-disciplined but also deliver altruism. The two novel features combined ensure effective educations on transforming society to achieve eco-civilization. In such way, man-kinds are still on the tract of becoming big. Aren't they?

In order to achieve a modest wellbeing society, people should be educated to come into close contact with the nature. Through contact, understanding and feeling the close relations between humans and the nature can be deepened and widened.

Key Words: self-discipline, diligent, Satoyama, living-creature conservation

嘉南地區國土生態保育綠網建置及推動策略

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摘要

自 2018 年起，農委會林務局推動臺灣國土生態保育綠色網絡的建置，其目的在結合里山倡議的精神，營造環境友善、社區參與之社會-生產-生態地景/海景。因此本研究目標在規劃嘉義及臺南區域生態熱點及廊道，建置嘉南地區國土生態綠網，並建議區域內保育復育行動策略。首先盤點嘉義縣市及臺南市轄內淺山、平原、濕地及海岸區域生物多樣性資料，特別是黑面琵鷺、水雉、山麻雀、草鴞、黃鸝、諸羅樹蛙、台灣爺蟬等物種，並針對較欠缺生態資料之邊際農地及嚴重地層下陷等地區進行補充調查，以作為評定生態熱點之基本資料。基於前述所彙整之生態基本資料，參考野生動物保護區、國家濕地及國家公園之核心區，瀕危種、特有種及物種多樣性等準則，評定應優先保育的熱點。其次是考量水系、灌溉埤圳、保安林及既有保育區帶等因素，串連熱點成為線狀（或帶狀），初步規劃出 3 條南北向保育軸帶：海岸濕地保育軸、農塘埤圳保育軸、森林湖泊保育軸，這三條軸帶正反應淺山、平原及海岸三種不同的社會-生產-生態地景/海景(SEPL)。此外，研究範圍內北起北港溪、南至二仁溪，區內 5 條重要水系朴子溪、八掌溪、急水溪、曾文溪及鹽水溪，正好由山區及海岸串連前述 3 個保育軸帶。藉由這 3 條南北向、5 條東西向保育軸廊道，建構嘉南地區國土生態綠網。本研究建議嘉南地區國土生態綠網之保育推動策略，可藉由跨機關合作推動熱點與廊道保育行動，除既有保護區型態外，次生林、農田、埤塘、魚塭、草生地等生態熱點廊道，大都為鑲嵌地景且多為私有地，應考量里山倡議、生態系統取徑、明智利用等精神，藉助社區型保育方法，加強社區及民眾培能及參與。

關鍵字：生態綠網、保育軸、里山倡議、社區型保育、嘉南地區

CONSTRUCTION AND PROMOTION STRATEGY OF NATIONAL GREEN ECOLOGICAL CONSERVATION BY ESTABLISHING A GREEN NETWORK IN CHIAYI AND TAINAN, TAIWAN

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Abstract: From 2018, the Forestry Bureau of the Council of Agriculture has promoted the establishment of a green network for national ecological conservation in Taiwan. The purpose of the green network is to combine the spirit of the Satoyama Initiative to create a socioecological production landscape and sea view, including a environment friendly societies and community participation. Therefore, the goal of this study is to identify ecological hotspots and corridors in Chiayi and Tainan, Taiwan, for building a green ecological network and to propose strategies for conservation and rehabilitation in the region. First, we searched for related studies that contained biodiversity information, including shallow mountains, plains, wetlands, and coastal areas within the jurisdiction of Chiayi and Tainan. We focused on several species, such as the black-faced spoonbill (Platalea minor), pheasant-tailed jacana (Hydrophasianus chirurgus), russet sparrow (Passer rutilans rutilans), australasian grass-owl (Tyto longimembris pithecops), black-naped oriole (Oriolus chinensis diffuses), farmland tree frog (Rhacophorus arvalis), and formosan giant cicada (Formotosena seebohmi). We then conducted supplementary investigations on areas for which ecological data, such as marginal agricultural land and severe stratum subsidence, were lacking. We considered these data as basic ecological information for assessing ecological hotspots. On the basis of the ecological information, we referred to the guidelines for wildlife refuges, the core area of the national wetlands and national parks, endangered species, endemic species, and species diversity, and assessment criteria for priority conservation. Second, we also considered other factors such as the water system, irrigation, and existing conservation zones. These zones and ecological hotspots form a line (or strip). Our initial plan included three north–south conservation corridors: coastal–wetland conservation corridor, farm pond–irrigation pond conservation corridor, and forest–lake conservation corridor. These three corridors reflect three types of socioecological production landscapes and sea views, namely shallow mountains, plains, and coasts. Moreover, the study area was from the Beigang River to the Erhjen River. The study area included five important east–west water systems in the area: Puzi River, Bazhang River, Jishuei River, Zengwun River, and Yanshuei River. Those rivers flow from mountainous areas to the coastal area and are connected to the three north–south corridors. By involving the three north–south

and five east–west conservation corridors, the ecological green network of the territory of Chiayi and Tainan was constructed. This study suggests a strategy for national ecological conservation by establishing a green network involving hotspots and corridors in Chiayi and Tainan through cross-institutional cooperation. Except the existing protected areas, most of the ecological hotspots and corridors are secondary forests, farmlands, ponds, fish rafts, and grasslands; these areas are private lands. We should consider the spirit of Satoyama Initiative, use the ecosystem approach, and wise use. By promoting community-based conservation, the community and people will increase their capacity and participation in conservation.

Key Words: ecological green network, conservation corridor, Satoyama Initiative, community-based conservation, Chiayi and Tainan

台灣西南沿海的黑面琵鷺環境承載量與保育策略

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摘要

2011 及 2018 年春天的全球黑面琵鷺普查，台灣度冬區的數量驟減 446 隻(-34.8%)及 406 隻(-15.6%)，相關理由眾說紛紜。本研究(1).分析自 2013 年至 2018 年於台灣西南沿海進行的魚類採集資料，探討其食源是否充足；(2).分析台江國家公園及台南鳥會，自 2007 年至 2018 年黑面琵鷺度冬期間的調查資料(每半個月 1 次)，探討其族群在個濕地間移動的原因；(3).並在七股鹽田濕地進行鳥類調查(設置 8 個樣區每半個月一次)，希望針對黑面琵鷺提出棲地改善與保育策略。據翁義聰等人報導：黑面琵鷺的食源主要包括豆子魚及吳郭魚。研究結果如下：(1).近 6 年於台灣西南沿海進行魚類採集，共獲 59,547 隻魚，其中 7,714 隻(13.0%)為 Mugilidae 鯔科，牠們的體長約為 10.2~15.7 cm 及重量約為 7.1~77.1 g 魚的大小很適合黑面琵鷺。(2).依養殖魚塭及河口分布，將雲林成龍濕地至高雄永安濕地分成 3 區，主要棲息範圍七股鹽田與曾文溪口之族群數量逐漸下降(Pcz = -2.9429 x + 75.855 (R2 = 0.8828)，布袋與北門範圍之族群數量逐漸上升(Pbb = 2.8929 x + 0.178 (R2 = 0.9192)，而四草與永安範圍族群數量緩慢上升(PSY = 0.0334 x + 24.154 (R2 = 0.0018)等。(3).於七股濕地的調查共紀錄 85 種 83,141 隻，累計數量依次為黑腹濱鷸有 20,501 隻(24.7%)、東方環頸鴴有 19,496 隻(23.4%)、裏海燕鷗有 5,590 隻(6.7%)、金斑鴴有 5,563 隻(6.7%)、紅胸濱鷸有 3,923 隻(4.7%)等分布於淺水區，赤頸鴨有 3,894 隻(4.7%)分布於樣區 3、4 及 6，保育類的黑面琵鷺有 1,280 隻(1.5%)，則分布於樣區 5。七股鹽田面積 2,606 公頃，除 1,482 公頃劃為國家濕地外，尚有 1,124 公頃且土地僅小量地層下陷，是可規劃自然感潮與進行棲地改善。依據先前及近年布袋濕地研究結果，黑面琵鷺來台灣度冬初期使用大量魚塭收成後的下雜魚，度冬後期因下雜魚減少，而轉至河口與潮間帶覓食。台灣西南沿海的鯔科魚類自入冬後開始陸續繁殖，幼魚則在沿海濕地成長，若能改善七股鹽田棲地，引入更多魚苗必能增加黑面琵鷺的食源，讓其族群趨於穩定成長。

關鍵詞：黑面琵鷺、環境承載量、保育策略、鹽田濕地、台灣

ENVIRONMENTAL CARRYING CAPACITY AND CONSERVATION STRATEGY FOR THE BLACK-FACED SPOONBILL (PLATALEA MINOR) ON THE SOUTHWEST COAST OF TAIWAN

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Abstract: According to 2011 and 2018 International Black-faced Spoonbill Census, the ethnic number of these spoonbills plummeted by 446 (−34.8%) and 406 (−15.6%), respectively, during winter in Taiwan. Thus, we analyzed fish collection data for 2013–2018 obtained from the southwest coast of Taiwan and explored whether the food source is sufficient. Moreover, we analyzed the survey data of Taijiang National Park and Tainan Bird Club pertaining to the black-faced spoonbill during the winters from 2007 to 2018 (the data collection frequency was once every 15 days) and discussed the reasons for the movement of their ethnic groups between wetlands. In addition, we conducted bird surveys in the Cigu Salt Pan Wetland and proposed strategies for habitat improvement and conservation of the black-faced spoonbill. For this, we sampled 8 plots and data were collected once every 15 days. The research results are as follows. The fish stock was collected from the southwest coast of Taiwan got nearly 6 years. The total number of fishes collected was 59,547. Among them, Mugilidae fishes were 7,714 (13.0%), which had a body length of 10.2–15.7 cm and a weight of approximately 7.1 –77.1 g, and were suitable food for the black-faced spoonbills. (2) On the basis of the distribution of farmed fish ponds and estuaries, the area from the Chenglong Wetland (at Yunlin) to the Yongan Wetland (at Kaohsiung) was divided into three sections. The primary population of Mugilidae fishes decreased gradually from the Cigu Salt Pan Wetland to the Zengwun estuary area [Pcz = −2.9429x + 75.855 (R2 = 0.8828)], whereas that from the Budai Salt Pan Wetland to the Beimen Wetland gradually increased [PBB = 2.8929x + 0.178 (R2 = 0.9192)] and that from the Sihcao Wetlands to Yongan Wetlands increased slowly [PSY = 0.0334x

+ 24.154 (R2 = 0.0018)]. (3) A total of 85 species with a total population of 83,141 were recorded in the survey of the Cigu Salt Pan Wetland. The cumulative number was 20,501 (24.7%) for the dunlin (Calidris alpina), 19,496 (23.4%) for the Kentish plover (Charadrius alexandrinus), 5,590 (6.7%) for the Caspian tern (Hydroprogne caspia), 5,563 (6.7%) for the Pacific golden plover, and 3,923 (4.7%) for the red-necked stint distributed in shallow water. In total, 3,894 (4.7%) Eurasian wigeon (Anas penelope) were distributed in sample plots 3, 4, and 6. There were 1,280 (1.5%) black-faced spoonbills in the conservation category, which were distributed in sample plot 5. The area of the Cigu Salt Pan Wetland is approximately 2,606 hectares. In addition to the 1,482 hectares that is classified as a national wetland, there is 1,124 hectares of wetlands and only a small amount of land subsidy is available. Natural tidal improvement and habitat improvement can be planned and implemented. The analysis of data from previous and recent studies on the Budai Salt Pan Wetland revealed that black-faced spoonbills come to Taiwan in winter to feed on the large amount of coarse fishes available after fish harvesting. In the late winter of the periods studied, the number of coarse fishes reduced, and thus, the black-faced spoonbills moved to the estuary and the intertidal zone for feed. The Mugilidae begins to breed on the southwest coast of Taiwan after autumn, and the juveniles grow in coastal wetlands. If the Cigu Salt Pan Wetland can be improved, that is, if more fries are introduced, the food source of the black-faced spoonbill will increase, and then, their ethnic numbers will increase steadily.

Key Words: *Platalea minor*, carrying capacity, food source, movement, Taiwan

台灣東部重要鳥類多樣性地區知本濕地的植物多樣性動態研究

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摘要

知本溼地是台灣東部海岸少數的鳥類重要棲息地(IBA)，同時為台灣少有的大面積且未受人為開發的海岸溼地。目前於知本濕地所記錄的鳥種達 160 種，其中 **27** 種為保育類鳥類，其中更有 8 種保育類鳥類於此區域有穩定的繁殖族群。顯示知本濕地對於鳥類保育有重要的價值，此區域尚未受任何法定保護區的保護，也無正式的植被調查政府報告或文獻記載。因此本研究首先要瞭解知本溼地裡面植物物種組成，我們於知本濕地範圍內設置 58 個永久小樣區，根據我們的調查結果，依據植被優勢物種組成與濕地核心位置為主軸，可劃分成四大樣區域。根據春夏秋冬四季於 58 個樣區的調查，用以了解知本濕地的植物物種組成、植物社會分布，以及後續植被消長的動態研究。基本上調查結果顯示四大區域內植被環境呈現多樣性，調查共計 41 科 113 屬 137 種維管束植物，其中台灣原生植物占比 0.61。而木本最優勢植物銀合歡，草本植物最優勢物種為大黍、巴拉草、鋪地黍。結果顯示知本溼地雖然以外來植物最為優勢，但卻在缺乏人為建築干擾因子的偶然情況下，演化出給予鳥類棲地生態棲位的最佳適應度。此研究結果可作為後續規畫設置鳥類保護區的基礎資料。

關鍵詞：生態、植被生態、濕地、植物優勢度、鳥類多樣性

DYNAMICS OF PLANT DIVERSITY IN ZHIBEN WETLANDS IN IMPORTANT BIRD DIVERSITY AREAS OF EASTERN TAIWAN

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Abstract: Zhiben Wetland is one of the few important bird habitats (IBAs) on the eastern coast of Taiwan. It is also a rare and undeveloped coastal wetland in Taiwan. Up to date, there are 160 birds species recorded in Zhiben Wetland, 27 of which are conservation-type birds, and 8 of them have stable breeding populations in this area. The Zhiben Wetland has great value for bird conservation. This area has not been protected by any legally protected area, nor is there a formal government report or documentary on vegetation survey. In this study, we first understand the composition of plant species in Zhiben Wetland. We set up 58 permanent sample plots within Zhiben Wetland. According to our survey results, based on the composition of dominant species in the vegetation and the core position of the wetland, we can be divided into four large areas. According to the survey of 58 plots in the spring, summer, autumn and winter seasons, it is used to understand the plant species composition, population distribution, and the subsequent dynamics of vegetation growth in Zhiben wetland. Basically, this study indicates that the vegetation in the four regions is diverse. A total of 137 species of vascular plants under 113 genera, 113 families, and a total of 0.61 of Taiwan native plants were surveyed. The most dominant species of the woody plant is Leucaena leucocephala. The most dominant species of herbaceous plants are Daphnia, Barra grass, and Pamukka. The results show that although the Zhiben wetland is the most advantageous of the exotic plants, it has evolved the best adaptability to the ecological niche of the bird habitat in the absence of artificial building interference factors. The results of this study can contribute for the subsequent planning of bird protection areas.

Key Words: Ecology, Plant vegetation ecology, wetlands, plant dominance, birds diversity

推廣友善耕種保育水雉（Hydrophasianus chirurgus）實踐案例分享

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摘要

本研究以「水雉生態教育園區」從 98 年發現水雉誤食毒餌死亡，每年 12 月到 1 月巡守有水雉出現的區域，透過巡守遇到農民直接與農民面對面溝通，歸納出農業現況與農民的需求，擬定策略透過從社區、學校與參觀者進行環境教育、增加有機友善耕種農產品與農民本身的價值、教導農民執行環境教育活動，促進生產者與消費者面對面的溝通，並透由「社會參與」與「公私協力夥伴關係」，支持友善耕種農民達到生態、生產與生活三生共贏的模式，持續保育水雉，並以人與生態和諧共存為終極目標。

從民國 98 年發現水雉誤食毒餌死亡後，園區即以「對話尊重」、「信任建立」和「目標共識」為理念，開始採取下列多元的行動與社會展開對話和互動：1.與水雉中毒田區內的農友聊天，了解他們的想法，進而勸導、陪伴和推廣保育理念，並建立社區友善耕種溝通平台；2.協助具「綠色保育標章」農友，依個別狀況給予農友建議，增加友善耕種農產品的產值，並教導與陪伴環境教育活動執行，促進生產者與消費者的對話，增加多元經濟收入；3.邀請社會大眾與企業一起加入共同推展；4.驅鳥裝置的研發；鼓勵農民以驅鳥代替毒鳥。

研究進行至今的結果顯示：1.開辦的友善耕種交流平台，定期邀請專家和農民做分享，每場皆有 10 位價值觀相近的農民參與；一般友善耕種講座會有超過 20 位的民眾參與。2.透過社會大眾與企業訂購友善耕種的菱角與生態米，皆能將農民的米與菱角銷售完畢；3.5 位自立品牌年輕農民的米都有自己固定的客群並於 2 月內就銷售完畢。4.官田地區 95%以上民眾，確定知道不能用毒餌毒鳥。5.水雉冬季族群數量已於 105 年超過 1000 隻以上，夏季族群數量穩定成長中。

關鍵字：水雉、社會參與、公私協力夥伴關係

A FRIENDLY FARMING CASE FOR CONSERVATION PHEASANT-TAILED JACANA（HYDROPHASIANUS CHIRURGUS）

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Abstract: The purpose of this study was to try the strategies to promote friendly farming. The formulation of the strategies based on interviews with farmers from the Jacana Ecological Education Park investigating farmland poison bird from 2009 years to the present. Develop strategies to educate communities, schools and visitors by environmental education. And not only increase product value but also increase farmers' value. It also gives opportunities for producers to communicate with consumers. For achieve ecology, production and life by social participation and public–private partnerships to support and encourage farmers to participate in the protection of pheasant-tailed jacana and harmony between men and farmland.

In 2009, mass pheasant-tailed jacana deaths were found in the fields nearby the park, killed by pesticides. The staffs of the park began to work with the famers to solve the dilemma. The actions were based on three concepts: listening to different opinions with fully respect, building trust to each other, obtaining consensus to live with animals in a harmonic way. The staffs took action in multiple directions: 1. Attempting to understand the farmers' thoughts, communication and coordination platforms in local community were settled up with farmers who used pesticides to control vertebrates in their fields. The platform would then give them advises and promote the concept of conservation. 2. To increase the value of green conservation label agricultural products, and accompanied the farmers to cooperate with experience activity of environmental education. From experience activity planed the producer and consumer face-to-face communication and had diversified economic income. 3. Designing and holding environmental education activities and games about "conservation of jacana" to encourage people and companies joined the action of "consuming water chestnuts to help the jacana" through the activities. 4.To advise the farmers to get rid of the birds in a friendlier way.

The results indicated that : 1. The communication platforms about eco-friendly agricultures invited experts and farmers to share their opinions, there were 10 farmers with the same concept participated in each session. In general speech about friendly farming, there were over 20 people participated. 2. The farmers' rice and water chestnuts（Trapa） can be sold . 3. The five young farmers can sale out their own agricultural products between 2monthers. 4. More than 95% of the people in Guantian area know that they cannot use poison bait poisonous birds.5. The number of winter populations in pheasant-tailed jacana has exceeded 1,000 in 2016, and the number of summer ethnic groups has grown steadily.

Key Words: pheasant-tailed jacana（Hydrophasianus chirurgus）、social participation、public-private partnerships

台灣五十二甲稻田濕地對越冬水鳥的保育意義：在休耕季節

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摘要

在過去的幾十年中，秋冬季在宜蘭縣52甲濕地提供水鳥的棲息及覓食的場所。我們研究的主要是長期監測52甲濕地，提供了關於鳥類群落長期趨勢，而且探討稻田濕地管理與濕地鳥類越冬與覓食活動的季節性，並有助於稻田濕地的規劃。為了調查水鳥群落利用稻田濕地和水鳥群落結構的時期。從2003年1月到現在，我們徒步進行了每月鳥類調查(因冬候鳥北返，5月、7月及9月不調查)，計算和識別採樣區內的所有物種，長期調查可以了解氣候衝擊和稻田濕地景觀波動的影響。52甲稻田每年於6月至7月一期收穫，氣候影響水鳥對濕地的利用，大白鷺和小白鷺等涉水鳥類在淹水休耕地中最為豐富。 9月至1月，在秋季雨季，部分田地暫時被雨水淹沒，許多鷸鴴被吸引到種植前的田地。11月至2月東北季風季節開始逐漸達到高峰期，水鳥的物種豐富度和豐度逐漸增加；5月-10月鳥類物種組成改變，除了雁鴨及鷸鴴鳥類北返，棲地環境受稻田耕種影響，鳥類種類及個體量明顯減少，鳥種組成以陸鳥為優勢。52甲濕地以稻田為主，於農耕型態及季節降雨的因素，濕地棲地的型態是隨農作時間及雨量而變動，1月時開始整地放水準備插秧時，有不少雁鴨、鷸鴴在未插秧的田地活動為其北返儲存能量。插秧後棲地覓食的影響，則稻田的鳥類減少，廢耕地有較多的鳥類活動。經長期調查(1998-2017)結果每10-4月的月平均個體數有增加的趨勢。由傳統農業的休耕地、廢耕地的田間邊緣和半自然棲息地已被認為是促進水鳥成長的關鍵因素。政府和環境組織都應重視保護水鳥和復原稻田濕地生態系統及友善稻田生態環境的農民。復原五十二甲稻田生態系統是通過管理策略恢復物種多樣性，並且在復原稻田濕地棲息地方面取得了相當大的成功。五十二甲濕地鳥類群落被認為是濕地生物多樣性的良好指標，它們對過去幾十年稻田濕地土地利用變化做出了反應。長期調查表明，具有保護價值的濕地鳥類群落增加了稻田濕地的多樣性。通過管理策略，在水稻種植時期生產優質稻米。然而，還需要進行研究提供農民最佳可行策略，以找到解決五十二甲濕地當地條件的最佳解決方案。今天不僅在宜蘭，在整個台灣，都需要採取補救措施，例如重新連接友善稻田和復原濕地，這使得農民能夠在不降低自然棲息地生態價值的情況下實踐傳統農業。

關鍵詞：濕地、稻田、水鳥、復原

CONSERVATION IMPLICATIONS OF RICE FIELD WETLANDS FOR WINTERING WATERBIRD IN 52 CHIA, TAIWAN: DURING THE FALLOW SEASON

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Abstract: In past decades, water birds wintering in agriculture areas of rice field wetland have partially or completely from stopover and foraging on rice fields in 52-chia, I-lan county, Taiwan. The main objectives of this study were the intensive monitoring not only provided important information on long-term trends in bird communities but also improved our scientific understanding of suitable combined anthropogenic wetland-rice fields management for foraging of wetland birds and contributes to the planning of rice field wetland habitat management projects. In order to determinate periods of waterbird community use of the rice field wetlands and water bird community structure. We performed monthly bird surveys on foot, counting and identifying all species in sampling area from January 2003 to present (May, July and September no surveys), long enough to investigate impact of climate and landscape fluctuation. The lunar calendar of rice fields growing and climate affect waterbirds use of wetlands, 52-Chia rice fields harvested one season. In September to January, some parts of fields were temporarily flooded by rain in autumn wet season, many shorebirds were attracted to the pre-planting fields. The species richness and abundance of water birds increased gradually begin northeastern monsoon seasons to a peak November – February. Some parts of fallow semi-natural fields were submerged by heavy rain in whole years and covered by aquatic plants such as Eichhornia crassipes. As tilling occurred, in a parade of foraging birds following behind machinery in spring. During rice planting period, farmers desire to manage rice fields for better rice growth, which is not like water bird feeding on rice fields, some farmers scare winter stopovers water birds off their sowing and transplanting rice fields. This behavior has had important affects on waterbirds and landbirds foraging habitats and distribution. After harvest of rice period when fields were cleared, bared and flooded. Shorebirds were most abundant during their autumn migrations, which also coincided with availability of large expanses of shallow water in flooded in rice fields, a preferred habitat for foraging. As northeastern monsoon and rainy season beginning in September. It is possible that field conditions were best suited for shorebirds during migration when shallow water and recently cleared soils of initial flooding rice field attracted shorter-legged substrate foragers. Wetlands exhibited two differentiated periods in bird community use, one from October-April and the other from May-August. The October to April period consisted of the migratory and wintering periods. November to March was characterized by greater abundances of birds, the presence of wintering groups, and foraging in rice field wetland. During beginning of spring (立春), particularly from January to February, dominant groups were the most numerous species in the flooded fallow fields, left ratooned fallow field and tilled rice fields. The March to April period corresponded to the post-spring migration of some numbers of individuals. May – September were

accompanied by an increase in the numbers of individuals of inland birds. Set-aside fields, unplowed field margins and semi-natural habitats that are maintained by traditional low-intensity farming, have been recognized as key factors contributing to the wellbeing of water birds. Both government and environmental organizations should recognize support farmers who want to contribute to friendly habitat quality enhancement by the protection of water birds and restoration of rice field wetlands ecosystem. Restoration of 52-chia rice field ecosystem is the science of restoring species diversity through focused management strategies and considerable success has been achieved in the restoration of rice field habitats. 52-chia wetland bird community are considered good indicators of wetland biodiversity, they respond to rice field wetland land-use changes in past decades. Long term surveys illustrate that conservationally valued wetland bird communities are in increase diversity of rice field wetlands. Safely produced high-quality rice through focused management strategies, in rice plant timing. However, the best available strategies to the farmer are needed for research to find that optimal solutions that address the 52-chia wetland local conditions. Today there is great demand, not only in I-lan but throughout Taiwan, for incentives approaches, such as reconnecting friendly rice fields and restoring wetlands, which allow rice farmers to practice traditional agriculture without degrading the ecological value of natural habitats.

Key Words: wetland, rice field, water bird, restoration

臺灣森林濕地初步的植群分類架構

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摘要

森林濕地乃指位於森林生態系統中的濕地，林務局在 101~105 年推動的「臺灣森林濕地資源調查先導計畫」及「全國森林濕地多樣性調查及監測計畫」所建立的 107 處森林濕地的生物資源調查資料，為往後的濕地研究提供了豐富的基礎資料。本研究以此資料為基礎來進行臺灣森林濕地的植物樣區分析及植群分類，分析方法為降趨對應分析、矩陣群團分析及雙向指標種分析法，分類結果依照歐洲法瑞學派的 Braun-Blanquet 系統來建立臺灣森林濕地的植群分類架構。結果共分為五個群級和八個群集，目前已完成漂浮植物群級、沉水植物群級、浮葉植物群級及沼澤林群級四個群級的分類架構建立，底下包含 6 個群團及 18 個群叢。

關鍵詞：森林濕地、臺灣森林濕地資源調查先導計畫、全國森林濕地多樣性調查及監測計畫、植群分類、Braun-Blanquet 系統

THE PRELIMINARY VEGETATION CLASSIFICATION FRAMEWORK OF FOREST WETLANDS IN TAIWAN

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Abstract: The “forest wetlands” refer to forest ecosystem wetland, which corresponds to mountainous regions of Taiwan. In 2012~2016, Forestry Bureau executed “Pilot project of resource investigation for forest wetlands of Taiwan,” and “Investigation and monitoring of biodiversity of forest wetlands” two projects. The biological resources survey data of 107 forest wetlands had been established. It provides a wealth of basic information for future wetlands research. This study used the database to analyze the plots of plant and classify the vegetation. The methods this study used are Detrended Correspondence Analysis (DCA), Cluster Analysis and Two-Way Indicator Species Analysis (TWINSPAN). The vegetation classification framework of forest wetlands in Taiwan implemented based on the Braun-Blanquet system of the European Zürich-Montpellier school. The result grouped plant plots into five classes and eight orders, and the vegetation classification of six alliances and 18 associations below four classes (floating plant class, submerged plant class, floating-leaved plant class and swamp forest class) had been completed.

Key Words: forest wetlands, Pilot project of resource investigation for forest wetlands of Taiwan, Investigation and monitoring of biodiversity of forest wetlands, vegetation classification, Braun-Blanquet system

建物擴張對宜蘭水稻田鳥類多樣性的衝擊

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摘要

農田是許多生物的棲息環境,在全球天然濕地流失下,也是重要的替代棲地,然而農業集約化、都市化、農業地景破碎化等亦造成全球農業生物多樣性快速減少。在台灣，大量候鳥會以水稻田與天然濕地為主要棲地，但水稻田同時也受到農舍建物快速擴張的嚴重影響。本研究之目的在於釐清建物擴張現象對於鳥類多樣性的影響，我們於 2016/2017、2017/2018 年冬季分別在宜蘭蘭陽平原選擇 42 及 51 個水田進行鳥類調查，並計算各樣區周圍 500 公尺緩衝區內地景因子及記錄田內的環境因子。結果顯示，農田與建物的最近距離對鳥類物種豐富度與豐度皆呈顯著正相關，道路鄰接側數呈顯著負相關；在 500 公尺緩衝區內的植被面積比例對草生性鳥類包括秧雞科、田鷸屬的物種豐富度呈正相關，水體面積比例則對雁鴨科鳥類的物種豐富度及豐度皆亦呈正相關。不同生態同功群的鳥種對於農田內環境因子(水深、植被覆蓋度、裸地比例)各自呈現不同的微棲地偏好，雁鴨科的物種豐富度及豐度與水深呈正相關，然而濱鷸屬、鴴屬等小型水鳥則與水深呈負相關；田內植被覆蓋度對於草生性鳥類則呈正相關，對濱鷸屬、鴴屬等小型水鳥則為負相關。總而言之，農舍擴張與道路開發將會嚴重衝擊宜蘭農田環境的鳥類多樣性,建議在休耕期保留雜草或再生稻於田內供田鷸屬、秧雞科鳥類棲息,維持低水位供各種水鳥覓食，將有助於保育農田濕地的鳥類多樣性。

關鍵詞：濕地保育、農舍擴張、水稻田、鳥類多樣性

IMPACTS OF URBAN SPRAWL ON BIRD DIVERSITY IN RICE PADDIES OF TAIWAN

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Abstract: Farmlands are important habitats for many creatures, and also regarded as compensative habitats under global natural wetlands loss. However, agricultural intensification, urbanization and landscape fragmentation have threatened farmland biodiversity worldwide. In Taiwan, both rice paddies and natural wetlands are important habitats for many migratory waterbirds, but rice paddies have been seriously encroached by urban sprawl. This study examined the effects of urban sprawl on bird diversity. From 2016 to 2018, we conducted bird surveys, examined landscape structure and measured field conditions of 93 rice paddies in Ilan County, Taiwan. Field survey revealed that distance to nearest building and adjacent sides of paddies to roads were positively and negatively correlated with bird species richness and abundance respectively. Vegetation area ratio in the 500m buffer zone was positively related to bird species richness of grassland species such as *Gallinago*, and water area ratio was positively related to species richness and abundance of Anatidae. Avian guilds also varied in their preferences to water level, vegetation and mudflat coverage. Species richness and abundance of Anatidae were positively correlated with water depth, while *Calidris*, *Charadrius* and *Pluvialis* were negatively correlated with water depth. Vegetation coverage within paddies was positively correlated with abundance of Rallidae and *Gallinago*, but negatively with both species richness and abundance of *Calidris*, *Charadrius* and *Pluvialis*. We suggest that urban sprawl and road development would cause negative impacts on bird diversity, while maintaining more vegetation coverage and lower water level in paddies would be important practices to conserve bird diversity in rice paddies.

Key Words: wetland conservation, urban sprawl, rice paddy, bird diversity

2009 至 2018 年鰲鼓濕地森林園區之陸鳥與水鳥的族群變化趨勢

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摘要

鰲鼓濕地是台糖公司在 1964 年所填海造陸形成的海埔新生地，現今區域內主要有人工造林地與濕地等兩大類型棲地。鰲鼓濕地具有豐富的鳥類資源，長期的鳥類監測將有助於園區的保育與經營管理。本研究自 2009 年 10 月開始，分別在人工造林地設立 14 個定點樣區，在濕地區域設置 5 個 200×200 m 區塊樣區，於每年 10 月至隔年 2 月進行 8 次鳥類調查。結果近 9 年共記錄 133 種 97,364 隻次的鳥類，其中包含陸鳥 62 種 13,590 隻次；水鳥 71 種 83,774 隻次。人工造林地與濕地區域的鳥種組成具有明顯差異(ANOSIM test, $P < 0.001$)，各年的 Morisita 相似度指數介於 0.00015 至 0.0051 之間。分析所有 133 種鳥類的族群指數(bird population index, BPI)變化，發現鰲鼓濕地的鳥類族群自 2010 至 2013 年震盪上升，2013 至 2015 年逐步降低，2015 至 2018 年較無明顯變化，但均比 2012 基準年(100%)的指數低 15-20%。進一步比較陸鳥與水鳥的歷年 BPI 變化，發現 2013 年後的陸鳥 BPI 明顯高於 2012 年之前，其中尤以樹林陸禽(forest songbirds)族群上升趨勢較為明顯。水鳥 BPI 在 2014 年後偏低，其中又以水域泥岸游涉禽(water-shore waterfowls)及泥灘涉禽(mudflat shorebirds)的減少趨勢較為明顯。我們認為鰲鼓濕地近 9 年的鳥類族群變化趨勢，與園區自 2002 年開始進行平地造林，人工造林地樹木快速生長形成鬱蔽林地，以及近年濕地水位偏高等棲地變化具有高度關聯。

關鍵詞：鰲鼓濕地、鳥類組成、濕地、人工造林地、鳥類族群指標

POPULATION TRENDS OF LANDBIRDS AND WATERBIRDS IN AOGU WETLAND FOREST PARK OF TAIWAN DURING 2009-2018

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Abstract: Aogu Wetland, an area over 1,000-hectare, was reclaimed from sea in 1964 by Taiwan Sugar Corporation, and the site now consists two major habitats: natural wetland and plantation forest. The Aogu Wetland is wellknown for its large numbers of migratory and wintering waterbirds, and long-term avian monitoring can be served as indicators of biological integrity and ecosystem health. We conducted surveys at 14 points of plantation forests and five 200 x 200 m plots of wetland in Aogu Wetland. Winter bird census were made 8 times from Octoer to next February during 2009 and 2018. There were 97,364 individuals in 133 species recored in 9 years, including 13,590 individuals in 62 species of landbirds and 83,774 individuals in 71 species of waterbirds. The bird populaion compositions were significantly different between natural wetland and plantation forest (ANOSIM test, $P < 0.001$). The yearly indicators of Morisita's simility were in the range of 0.00015-0.0051. The bird population indices (BPI) of all bird species showed gradually and fluctuantly increased from 2010 to 2013, but decleased from 2013 to 2015. The indicators were not significantly different in 2015-2018, but all the values were 15-20% lower than the 2012 baseline data. We further evaluated the yearly variations of landbird and waterbird BPI and found the values of landbird BPI after 2013 were significantly higher than those before 2012, especially the increasing trend in forest songbirds. The values of waterbird BPI after 2014 were lower, especially the decreasing trend in water-shore waterfowls and mudflat shorebirds. We think the bird population trend in Aogu Wetland is highly related to the forestation in 2002 making the shadowed forest and the higher water level in wetlands during theses years.

Key Words: Aogu wetland, avian composition, wetland, plantation, bird population index

環境因子對鰲鼓濕地森林園區造林地鳥類群聚之影響

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摘要

棲地結構是影響鳥類群聚組成的重要因子。鰲鼓濕地自 2002 起開始的平地造林計畫，使大量農耕地轉變為造林地，而對於不同年份造林地結構如何影響鳥類群聚尚不清楚。因此本研究利用 2009、2010、2012、2013 年，在造林地的 14 個定點樣區的鳥類與植群調查資料，希望探討造林地之棲地結構與不同季節間鳥類群聚的關係。我們將鳥類分為地面覓食者、灌叢覓食者、樹幹覓食者、樹層覓食者、空中覓食者等 5 類生態同功群，棲地變數則結合歷年植群調查資料及 2010、2014 年 5 月在東石農場拍攝之航空照片，利用地理資訊系統以 5x5m 之解析度進行不同造林時期及結構之判讀，以了解棲地的組成。本研究針對各同功群挑選適當的環境因子以建立模型組，並利用廣義線性混合模型結合赤池信量準則，評估環境因子與同功群鳥種及數量的關係。結果顯示環境因子對各類同功群之數量及種類的影響皆不盡相同，地面覓食者及灌叢覓食者不論在數量或種類上，在秋冬時期分別與草地面積、地表覆蓋度呈現正相關。空中覓食者的數量及種類在夏、秋及冬季則隨著森林面積增加而減少。而樹層覓食者並無同時影響其數量及種類之因子。本研究結果對環境因子如何影響鳥類群聚提供了更進一步的認識，也提供未來調查棲地結構對各鳥類同功群影響之指標。

關鍵詞：造林地、覓食同功群、廣義線性混合模型、鰲鼓濕地

THE EFFECT OF ENVIRONMENTAL FACTORS ON AVIAN COMMUNITIES OF FOREST PLANTATION IN AOGU WETLAND FOREST PARK

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Abstract: Habitat structure is an important factor influencing bird communities. In Aogu Wetland, the farmland has been transformed into afforestation since 2002. However, it is not clear how afforestation in different stages influence the bird community composition.We used data from 14 sample areas in 2009, 2010, 2012, and 2013to understand the relationship betweenbird communities and afforestation. We divided foraging guilds into grass forager, shrub forager, trunk forager, canopy forager, and aerial forager. We digitized aerial photo from May 2010 and 2014 with 5 x 5m resolution and incorporated plant survey data to create environmental variables in relation to composition and structure. We built hypotheses regarding environment factors that may influence the abundance and richness by different guilds. We evaluated the relationship between abundance and richness and environment factors by using generalized linear mixed model with Akaike information criterion. Our results showed that the influence of environment factors varied for abundance and richness for different guilds. For grass forager and shrub forager in winter and autumn, both abundance and richness were positivelycorrelated with grass area and ground foliage coverage, respectively. A negative correlation was also found for aerial forager with forest area in summer, autumn and winter. We did not find variables that were correlated with canopy forager. Our study provided reference to understand the relationship between bird communities and afforestation and guidance for future management.

Key Words: afforestation, Aogu Wetland, foraging guild, generalized linear mixed model

失落的魚米之鄉—觀音新屋沿海社區的人地關係

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摘要

本研究探討桃園觀音新屋沿海地區居民整體生活環境的變遷以及與自然資源間的互動關係。觀音新屋沿海曾經是臺灣重要漁場與北台灣最大的糧倉，然而自 1970 年代工業區的開發後，漁獲大減、農業式微。本計劃透過與當地居民的質性訪談，瞭解在地居民長久以來與自然資源間的關係，也進一步地尋求當地居民與環境間互動的完整圖像。在我們的調查中，發現當地人與自然環境間具有複雜且多層次的關係。早期人們確實與海洋及土地有緊密連結，訪談間盡是居民靠海或以農維生的重要記憶，在居民回溯過往時，我們記錄到早年當地自然資源的富庶豐饒。自工業區進駐後，當地環境受到嚴重污染，整個海岸景觀及農耕生態發生劇變。工業區開發所帶來的一切，並無法使在地居民安身立命，反而嚴重地影響其所居住的沿岸生態與家園環境，甚而衝擊當地農漁業的發展。過去五十年來，官方與企業常企圖以各式說詞和策略矇騙、收買或圖利在地民眾，然而多數草根居民卻往往是最無力最需要協助的一群。在工業開發與追求經濟成長的同時，在地居民與海洋及土地間的連結漸呈斷裂，甚至連過去賴以維生的自然資源及生活產業，亦產生丕變。近幾年政府試圖在觀音新屋沿海一帶推行觀光休閒產業活動，然而卻因政策未能與當地生活及環境產生連結，無法整合出對當地有所裨益之產業。此外，隨著藻礁及環境議題備受關注，我們亦看到在地社群試圖從中找到立基，維護地方文史或倡議生態保護，嘗試重新找回這片土地與人之間的連結。本計劃讓我們重新思考人與土地間之關係，希冀藉由本研究，反思傳統大破大立的工業開發思維，重新建立起一套由下而上，具有觀音新屋在地特色、並維繫傳統生活形式的永續發展模式。

關鍵詞：人地關係、生活產業、永續發展、環境退化、藻礁

THE LOST LAND OF PLENTY- THE RELATIONSHIP AMONG LAND, SEA AND PEOPLE IN THE COASTAL AREA OF GUANYIN-XINWU

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Abstract: This study explores the changes in the living environment of the residents and their relationship with the natural resources in the coastal area of Guanyin-Xinwu. This area once had a large fishery and was dubbed the granary of northern Taiwan. However, since the development of the industrial zones from the 1970s, the fishery and rice yield have been declining tremendously. Through interviews with local residents, this project investigates the long-time relationship between local residents and natural resources. In our survey, we found a complex and multi-layered relationship among land, sea and people. In the early days, people did have a close connection with the surrounding nature, and this connection is an important part of their memory. We recorded many interviews that detailed the abundance of the local natural resources. But since the set-up of the industrial zones, the environment has been seriously polluted and the landscape has undergone dramatic changes. The development of the industrial zones has not enriched the local residents' lives, but impacted negatively on the local environmental integrity and the productivity of agriculture and fisheries. Over the past 50 years, government officials and companies have often persuaded or manipulated local people to agree to their own agendas, even though those residents are the most vulnerable stakeholders in the whole picture. On the pursuit of economic growth, the link between people and homeland has gradually broken and the natural resources that people depend on have decreased. In the recent years, the government has tried to promote tourism and hospitality industry in Guanyin-Xinwu area. But the failure to link the new policies to the local community has made it difficult to manage natural resources sustainably. Meanwhile, the local residents have addressed the issues of algal reefs and environmental concerns in an attempt to revisit their history, raise environmental awareness and envision the future of this community. This project will rethink the relationship among land, sea and people; reflect on the industrial development and propose a bottom-up approach to establish a sustainable lifestyle in Guanyin-Xinwu.

Key Words: algal reef, environmental degradation, living industry, man-land relationship, sustainable development

南桃園藻礁海河水系水生無脊椎動物多樣性調查

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摘要

桃園藻礁位於台灣西北沿岸，估計分布長度約為 27km，藻礁主要是由殼狀珊瑚藻經由分泌的碳酸鈣層層堆疊建構而成，生長速度緩慢，為世界少有的礁體，相關的生物研究很少，尤其藻礁底內的生物群聚資訊更為缺乏，本研究於藻礁範圍內於五個不同測站的潮間帶鑿取 20*20*20cm 的立方塊，敲碎後取出可見的生物進行物種鑑定及計數，分析其群聚組成及物種多樣性，建立藻礁無脊椎物種資料庫。此外，為瞭解藻礁受到河川可能帶來的陸源影響，亦針對對應的五條溪流進行水質及水生生物調查。

研究結果顯示，藻礁底內生物共計發現 4 大類群，包含軟體動物門、節肢動物門、環節動物門、以及星蟲動物門，共 25 科，超過 28 種底棲物種，其中以環節動物門以及星蟲動物門的數量最多，多數為珊瑚礁常見的物種，偏北側的三個樣站物種豐富度及歧異度較高，顯示此區域的棲地生態最為豐富。注入藻礁區的河口水質普遍不佳，部分水體的溶氧 BOD 及氨氮指數皆顯示不良，顯示藻礁可能存在被污染的壓力。部分河川捕獲毛蟹等兩側洄游的物種，也顯示沿岸藻礁區河口對河川上游生物相的重要性。

關鍵詞：藻礁、底內生物、無脊椎生物、河川

BIOTIC COMMUNITY OF AQUATIC INVERTEBRATES INNER THE ALGAL REEF AND ITS ADJUNCT RIVER SYSTEMS IN SOUTH TAOYUAN AREA

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Abstract: Taoyuan algal reef is located on the northwestern coast of Taiwan and is one of the rarest reef systems in the world. It is approximately 27 km long and a maximum of 450 m wide. The algal reef is mainly constructed by crustose coralline algae that stacked on the layer of calcium carbonate with very slowly growth rate. Only few studies about the biofauna associated with algal reefs have been conducted, especially the infauna information is rear. In this study, the 20cm*20cm*20cm* algal reef were collected in the intertidal zone at five different stations. All of the macro-infauna organisms were sorted and counting. Most of specimens were identified then species database established. The abundance and diversity were estimated. In addition, in order to understand the possible terrestrial effects of the upstream rivers, the water quality and aquatic organisms were investigated.

Total of 4 phyla, 25 families and more than 28 species were identified, include Mollusca, Arthropoda, Annelida and Sipuncula. The north three sampling sites were most abundance reflected the better environment. The function group composition is similar to coral reef system.

The terrestrial inputs of the rivers into the algal area were shown polluted with high nitrate ions and BOD values. The ecosystem of algal reef area were impacted by the contaminants in the catchment area of the terrestrial catchment. The catadromous mitten crabs were also surveyed at upstream sites. The estuaries of algal area are important to catadromous species.

Key Words: algal reef, infauna, invertebrates, river

台灣湧泉現況及生物多樣性

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摘要

湧泉在淡水水生生態系形成了重要淡水棲地，為淡水生物的新避難所(New-refuge)，同時提供人類民生之用，但是有關湧泉的研究過去卻不受重視。林務局在 2011-2015 年主導並支持台灣湧泉的研究工作，研究調查超過台灣 50 個湧泉的現況及生物多樣性。共計到種魚類，4 種龜鱉類，21 種淡水螺貝類，18 淡水蝦，18 種淡水蟹及 35 個門的水生昆蟲及 89 種水生植物。研究結果依照人類汙染及利用方式將湧泉可以歸類為五個類型。包括自然環境型、農村水圳型、都會綠洲型、保育熱點型及聚落文化型湧泉。可以不同利用程度的湧泉的進行保育行動、地方發展或文化保存面，建立多元的面向的保存及復育策略。目前湧泉遭受到不同的威脅，包括地下水枯竭水位降低，農業和工業的對水源及補注區的汙染，遊憩方式，外來種入侵及不當的水泥化工程，加上不正確的管理及利用方式如洗衣場、游泳池甚至成為排水溝。湧泉的重要性及復育必須被重視，需要結合生態學家、社區工作者、非政府組織以及地方政府，以及中央政府單位的通力合作，才能共同完成台灣湧泉的保育及復育。

關鍵詞：湧泉、避難所、復育、淡水生態

CURRENT STATUS AND BIODIVERSITY OF COLDWATER SPRINGS IN TAIWAN

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Abstract: Coldwater springs are a significant component, but have long been overlooked ecosystems in Taiwan. From 2011 to 2015, a major research effort has been supported by the Bureau of Forestry (BOF), and directed to assess the current status and biodiversity of 50 coldwater springs in Taiwan. With at least a biological survey was conducted on each spring, a diverse fauna and flora was identified, including fishes (55 species), turtles (4 species), mollusks (21 species), prawns and shrimp (18 species), crabs (18 species), aquatic insects (35 families), and aquatic plants (89 species) Based on the results of this study, we classified these springs into 5 human practices and disturbances categories.. The current threats to the Taiwan's springs included lowering and exhaustion of aquifer, water diversion, agricultural and industrial pollutions, tourism, exotic species, cemented engineering in lotic waters, and inappropriate human practices and managements like laundry pits, swimming pools, irrigation canals. Recently, the spring protection and sustainable use project is important, the great effort have been invested to cooperate ecologists, local communities, non-governmental organizations, local governments, and central governmental agencies like BOF to protect and rehabilitate the springs in Taiwan.

Key Words: cold spring, refugium, rehabilitation, freshwater ecology

推動里海倡議之淨灘機制—以白沙灣自然中心為例

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摘要

台灣北海岸具美麗之沙灘及海岸線，沿海社區漁業為主要產業，因過去污染物排放與東北季風及海流的因素，將各處的海漂物沖上岸，造成景觀與視覺上的影響，進而降低漁業及觀光品質。交通部觀光局北海岸及觀音山國家風景區管理處自 2011 年起舉辦基於里海倡議之「我愛淨灘」活動，獲在地居民熱烈響應，成功地凝具社區意識共同為推展觀光而努力，並結合學生公共服務時數認證機制及人性化線上申請系統之簡化行政程序，大幅增加民眾參與意願。每年淨灘人次與清運廢棄物數量逐年提升，由 2011 年的 3,306 人次成長至 2017 年的 30,393 人次，清除海漂物重量由 5.04 噸提升至 30.39 噸。此外，為推動環境教育，爰依本場域特色及處理海洋廢棄物為主軸，擬定之戶外教學「我愛淨灘」主題，並於 2018 年申請通過環境教育場所認證。淨灘活動能使人類與沿海環境逐漸恢復和諧關係，人類能與自然共存，逐步達成里海之目標，建立一個環保、安全、健康和友善的觀光環境。

關鍵詞：里海倡議(Satoumi Initiative)、淨灘(Beach clean up)、白沙灣自然中心(Baishawan Nature center)

A BEACH CLEAN UP SYSTEM TO PROMOTE SATOUMI INITIATIVE - ACCORDING TO THE BAISHAWAN NATURE CENTER CASE

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Abstract: The northern coast of Taiwan which owned one of the most beautiful beaches and seaside in the world. However, due to the uncontrolled pollution leaked out and pollutants carried by the east-northeast wind from the ocean. The quality of fishery and tourism industry are heavily affected. Since 2011, North Coast & Guanyinshan National Scenic Area actively organized“Beach clean up “based on Satoumi Initiative , event which aims to unite community to fight for our environment. In addition, the event also combined with “student social services” by providing user-friendly online application and recognition system. Thus, simplify the registration process and increase the motivation of applicants.The number of applicants and collected pollutants increase every year since 2011 where applicants increase from 3,306 people to 30,393 people and pollutants increase from 5.04 tons to 30.39 tons. In order to advocate the value of “beach clean up” event, Baishawan Nature Center are certified as an official environmental education classroom at 2018. We believe this event can assist us to create a eco, safe and healthy scenic area. At the same time, rebuild our sustainable relationship with the ocean as our Satoumi final goal.

KeyWords: Satoumi Initiative,Beach clean up,Baishawan Nature center

社區林業與濕地經營管理－以宜蘭縣無尾港文教促進會為例

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摘要

本研究係以執行完林務局社區林業二階計畫之宜蘭縣無尾港文教促進會為例，以質性研究為取徑，透過文獻回顧、參與觀察及訪談等方法，從 2015 年 11 月至 2017 年 12 月，共蒐集了 22 筆參與觀察紀錄及 18 筆訪談資料，採用生計分析架構（livelihoods analysis framework）來探討臺灣林務局社區林業政策的施行成效。研究結果顯示社區林業在輔助無尾港水鳥保護區與在地社區的夥伴關係，扮演了重要的角色，其連結社區參與，有助提升相關社會資本；有促進自然資本的正面效果；提供了專職行政秘書薪資支持，以增加無尾港文教促進會的財務與人力資本。但是對於保護區的經營管理層面來說，因無尾港水鳥保護區主要係由地方主管機關宜蘭縣政府主政，社區林業計畫若無法融入與整合其治理架構，就無法進一步發揮其效益。另外，二階計畫運作模式有輔導流於形式、審查缺乏整合及時程延宕等狀況。或建議釐清社區林業政策目標，可強化分權，將社區林業的執行完全交給林務局各林區管理處處理，提高一階計畫的運作彈性，來改進現有的狀況。

關鍵詞：生計分析架構、效能評量、保護區經營管理、社區參與、共管

COMMUNITY FORESTRY AND WETLAND: A CASE STUDY OF WU-WEI RIVER CULTURAL AND EDUCATION ASSOCIATION

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Abstract: Using the Wu-Wei River Cultural and Education Association as a case study, based on qualitative approach and adopting literature review, participant observation, and interview in the fields, this study aimed to apply the livelihoods analysis framework to discuss the effectiveness of community forestry in Taiwan. From November 2015 to December 2017, this study collected 33 records by participant observation and 21 records by qualitative interview totally. The results showed that the program played a key role in assisting the partnerships between local communities and the Wu-Wei-Kang Waterfowl Wildlife Refuge, which promoted community participation and relevant social and nature capital. It also had a positive effect on financial and human capital by sponsoring a full-time secretary of the association. Somehow, it would not be able to achieve optimal effects, if community forestry cannot be integrated in the governance of this refuge, as Yilan County Government being the major management authority. The results also showed that there were several weaknesses for the 2nd stage projects of community forestry, including formalism for empowerment, lacking integration for reviewing, and schedule delay for implementation. This study suggested that there was a need to clarify the objective of community forestry and to strengthen decentralization. It might improve flexibility of the 1st stage projects and current operation while assigning without hesitation the Forestry District Offices to implement community forestry.

Key Words: livelihoods analysis framework, effectiveness analysis, wildlife refuge management, community participation, co-management

跨公私部門合作之無尾港濕地潮間帶灘地營造

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摘要

本文探討無尾港濕地經由社區志工、學術單位、政府機關及施工廠商之討論合作，順利完成潮間帶灘地營造之過程及成果。無尾港核心保育區之水域，有水域水深過大及岸壁過於垂直等棲地問題。2017 年宜蘭縣政府完成私有地徵收作業，學術單位完成水文環境之水位及地形調查後，由學術單位建議將已徵收私有地之旱地型態營造復育為潮間帶灘地，以增加水鳥適宜之棲地環境，即成為無尾港公私部門共同參與之平台會議中之共識議題。學術單位依據水鳥喜好棲地及該地水文環境特性，規劃潮間帶灘地營造位置及高程。由宜蘭縣政府農業處委託具十數年無尾港棲地整理經驗之廠商施做，並由無尾港文教促進會的志工伙伴，協助共同監測潮間帶灘地施工進度及高程。施工過程中，由於潮間帶灘地開挖過深，經志工於退潮時段協助量測水深，再由縣政府及學術單位會同廠商商討後，進行灘地高程修改作業。本灘地施做與一般工程案件最大差異，為一般工程案件有制式工程設計圖，不易依據現地需求調整。而本灘地營造作業，經由公私部門緊密合作，彈性調整施做內容，順利完成水鳥喜好灘地營造。於 2018 年 8 月完成旱地之潮間帶灘地復育營造，復育操作面積約 8850 平方公尺（約 80 公尺*110 公尺），其中包括：潮間帶灘地面積約 3600 平方公尺（約 70 公尺*50 公尺）及自然圍籬堆土區 5250 平方公尺（約 80 公尺*65 公尺）。此公私部門緊密順利的成功合作經驗，可作為其他濕地棲地營造之重要參考。

關鍵詞：無尾港濕地、潮間帶灘地、公私部門、跨部門合作

THE CONSTRUCTION OF INTERTIDAL MUDFLAT BY THE COOPERATION BETWEEN GOVERNMENT'S AGENCY AND NON-GOVERNMENTAL ORGANIZATION IN WU-WEI-KANG WETLAND

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Abstract: This study successfully constructed an intertidal flat of Wu-wei-kang wetland via cooperation between community volunteers, academic units and government agencies, and communication with the contractor. Because deep water-depth and vertical river-wall led to the core conservation area of Wu-wei-kang wetland not suitable for waterfowl to inhabit, this study aims to build a suitable habitat for them. At first, Yilan county government compulsorily acquired the private land of the riverbank in 2017. Then academic units finished water level and topographic survey and suggested that private land with dry farming changed to the intertidal flats. As waterfowl suitable habitat established, it becomes a consensus issue of public-private partnership. According to waterfowl habitat preference and hydrological environmental characteristics, academic units designed intertidal flats that the height suits waterfowl to inhabit. Agriculture Department of Yilan County Government authorized contractor which have more than ten years of experiences in

the construction in Wu-wei-kang wetland to build the restore area. And besides, volunteers in the Association of Wu-wei-kang Culture and Education Promotion, a community organization that cares about Wu-wei-kang wetland, assist in monitoring process of the construction of the intertidal mudflats. However, in process of the construction, the contractor dug too deep. After community volunteers gave assistance in measuring water depth during the low tide, government and academic units had a discussion with the contractor about modification of the construction. Finally, the restoration of waterfowl habitat was successfully constructed in August 2018. The area, approximately 8850 m^2 (80 m*110 m), includes the intertidal mudflats for about 3600 m^2 (70 m*50 m) and mound area beside the natural fence which is about 5250 m^2 (80 m*65 m). This case was different from general engineering cases: general engineering case usually has a standard engineering design diagram and do not need to adjust accord with the local demand; this case completed to flexibly adjust engineering construction through the public-private partnership.

Key Words: Wu-wei-kang wetland, intertidal mudflats, cooperation between government's agency and non-governmental organization

臺灣森林濕地初步的植群分類架構

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摘要

森林濕地乃指位於森林生態系統中的濕地，林務局在 101~105 年推動的「臺灣森林濕地資源調查先導計畫」及「全國森林濕地多樣性調查及監測計畫」所建立的 107 處森林濕地的生物資源調查資料，為往後的濕地研究提供了豐富的基礎資料。本研究以此資料為基礎來進行臺灣森林濕地的植物樣區分析及植群分類，分析方法為降趨對應分析、矩陣群團分析及雙向指標種分析法，分類結果依照歐洲法瑞學派的 Braun-Blanquet 系統來建立臺灣森林濕地的植群分類架構。結果共分為五個群級和八個群集，目前已完成漂浮植物群級、沉水植物群級、浮葉植物群級及沼澤林群級四個群級的分類架構建立，底下包含 6 個群團及 18 個群叢。

關鍵詞：森林濕地、臺灣森林濕地資源調查先導計畫、全國森林濕地多樣性調查及監測計畫、植群分類、Braun-Blanquet 系統

THE PRELIMINARY VEGETATION CLASSIFICATION FRAMEWORK OF FOREST WETLANDS IN TAIWAN

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Abstract: The “forest wetlands” refers to wetland which was located in forest of mountains. In 2012~2016, Forestry Bureau executed two projects which was “Pilot project of resource investigation for forest wetlands of Taiwan,” and “Investigation and monitoring of biodiversity of forest wetlands”. Then, the biological resources survey data of 107 forest wetlands had been established. It provides a wealth of basic information for future wetlands research. This study used the database to analyze the plots of plant and classify the vegetation. This study was used those method of Detrended Correspondence Analysis (DCA), Cluster Analysis and Two-Way Indicator Species Analysis (TWINSPAN) to analysis. The vegetation classification system of forest wetlands in Taiwan implemented based on the Braun-Blanquet system of the European Zürich-Montpellier school. The result grouped plant plots into five classes and eight orders, and the vegetation classification of six alliances and 18 associations below four classes (floating plant class, submerged plant class, floating-leaved plant class and swamp forest class) had been completed.

Key Words: forest wetlands, Pilot project of resource investigation for forest wetlands of Taiwan, Investigation and monitoring of biodiversity of forest wetlands, vegetation classification, Braun-Blanquet system

竹北蓮花寺濕地瀕危珍稀植物之棲地復育

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摘要

本研究以人為控制及營造棲地方式，進行珍稀食蟲與伴生植物之保育及復育， 並監測棲地環境及物種數量變化。竹北蓮花寺濕地位處湖口台地邊緣，此內陸濕地孕育多種食蟲植物及珍稀伴生植物，但因攔砂壩興建後，造成棲地環境變動， 使珍稀植物瀕臨滅絕。故本研究以維護標的保育植物與周圍動植物共同形成的濕地生態體系為目標，主要保育 4 種食蟲植物：長葉茅膏菜、寬葉毛氈苔、小毛氈苔、長距挖耳草，及 3 種珍稀伴生植物：桃園草、田蔥、點頭飄拂草。荒野保護協會志工以定期人工修剪方式，將樣區內長葉茅膏菜周遭之競爭陽光之植物剪除。樣區外及走道定期以機械方式割除禾本科草類並移除草葉。冬季時期，長葉茅膏菜會枯萎死亡，此時進行大面積割草一次，並進行翻土工作，以促進來年長葉茅膏菜之種子能於春季濕度高及陽光照射下順利發芽。使食蟲植物及伴生珍稀植物能在此有穩定族群外，並以此處為種源，嘗試於環境特徵相近或歷史資料曾經分布之區域進行人工繁殖，期望小毛氈苔及長葉茅膏菜能於此棲地外也能有族群分布。於保育及復育植物生長區域進行分區，計算族群數量統計及分布情形。以 HOBO 監測站進行長時間微環境監測，蒐集樣區微氣候數據，每年進行一次土壤營養成分檢測。經過 101 年至 107 年的實地經營及管理經驗，透過適時適度的人為控制方式進行棲地維護，儘管歷經桃芝、納莉風災，至 107 年 8 月調查，仍保有 491 株長葉茅膏菜及 330 株小毛氈苔，保存了全臺最大族群的自然棲地，志工團體成功地復育經驗可作為其他類似濕地參考。

關鍵詞：蓮花寺濕地、食蟲植物、濕地伴生植物、長葉茅膏菜

THE RESTORATION HABITAT FOR RARE AND VALUABLE INSECTIVOROUS PLANTS IN LIANHUA TEMPLE WETLAND OF HSINCHU COUNTY

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Abstract: Jhubei Lianhua Temple Wetland located in HuKou tableland was rich with rare and valuable insectivorous plants and companion plants; however, their habitat has been disturbed because of dam constructing, causing those plants to be endangered. Therefore, this study conducted conservation and restoration by human control and habitat creation, and at the same time monitored the habitat environment and species number variation. Aiming at protecting the wetland ecosystem formed by the species worth conservation and other surrounding animals and plants, we set 4 insectivorous plants and 3 companion plants as target species, including the insectivorous：Drocera indica, D.burmanni, D.spatulata, Utricularia caerulea and the companions：Xyris formosana, Philydrum lanuginosum, Fimbristylis nutans. The volunteers of SOW (The Society of Wilderness) regularly pruned the plants competing sunlight with D.indica inside the sample plots by hands, and removed the Poaceae grasses mechanically outside the plots. In order to promote D.indica's seeds germination under humidity and sunny condition in spring, large-scale mowing and soil turnovering will be conducted in winter when they withered. In addition to stable the insectivorous plants' and companion plants' population, we take this wetland as a provenance and attempt to make artificial propagation in areas with similar environmental characteristics or those been recorded to exit the plants, expecting D.spatulata and D.indica to distribute not only in their current habitats. The population and its distribution were analyzed by partitioning the study area; moreover, long term microclimate data were collected by HOBO monitoring station, and the soil nutrient were analyzed once a year. Through the field management experience from 2012 to 2018, 491 D.indica and 330 D.spatulata have survived even from Typhoon Toraji and Nari after habitat maintenance using appropriate human control. The biggest natural habitat in Taiwan has been preserved, this successful restoration experience of SOW volunteer can be used as a reference for other similar wetlands.

Key words: Jhubei Lianhua Temple Wetland, insectivorous plants, wetland companion plants, Drocera indica.

火災對知本濕地鳥類組成影響初步研究

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摘要

台東知本濕地位置位於台東平原以南，匯集了縱谷與海岸線遷徙的候鳥，而大面積未受開發的荒地，提供了候鳥與過境鳥休憩的場域。國際鳥盟在 2004 年將知本濕地劃設為「重要野鳥類棲息地」。由於知本濕地常被作為其他用途，其陸域環境有許多畜牧在此放牧，而有意味不明的不定期人為大範圍火燒濕地，故此希望探討火災是否會影響鳥類棲地組成的變化，此為大三學生們專題研究的題目。本實驗調查從 2018 年三月一日開始，每星期固定周末到知本溼地連續觀察兩天，2018 年 5 月 27 日為火災發生日，在濕地研究地區中，此後分為火災區和非火災區兩種，以穿越線取樣法，紀錄常見的鳥類，其中主要以棕背伯勞(*Lanius schach*)、黃鸝(*Oriolus chinensis*)、白尾八哥(*Acridotheres javanicus*)、紅鳩(*Streptopelia tranquebarica*)、烏頭翁(*Pycnonotus taivanus*)、灰頭鷦鶯(*Prinia flaviventris*)，大捲尾(*Dicrurus macrocercus*)和家燕(*Hirundo rustica*)為最常見的鳥類並且族群數量最多。結果發現白尾八哥及大捲尾在火災區數量較多，所從事的活動以覓食居多；家燕在非火災區的數量較多，紅鳩、烏頭翁、灰頭鷦鶯在兩區差異不大，黃鸝跟棕背伯勞則在非火災區數量明顯比非火災區多，並且喜歡停留

在樹梢，樹種以銀合歡居多，推測為非火災區銀合歡數量非常多所致。灰胸秧雞(*Gallirallus striatus*)等較少見的稀有鳥類多出現於非火災區域覓食或休息。在火燒因子干擾的地區內，推測可能鳥類潛在獵物昆蟲在種類與數量上面遠低於非火燒因子干擾的區域，但缺少植物覆蓋的火災區內使的昆蟲等鳥類食物容易顯現行蹤而被捕食，較具侵略性的鳥種會於火災區域裏面優勢覓食，使的其他相對較溫和的鳥種火災數量稀少的鳥種無法與之競食。

關鍵詞：鳥類生態、火災生態、植被生態、濕地、干擾

PRIMARY STUDY OF FIRE EFFECT ON AVIAN COMPOSITION IN ZHIBEN WETLAND

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Abstract: Taitung Zhiben Wetland is located south of the Taitung Plain, where migratory birds migrated from the Taiwan East Rift Valley and the coastline, while a large undeveloped wasteland provides a shelter for migratory birds and transit birds. In 2004, BirdLife International designated the Zhiben Wetland as an important wild bird habitat. Because Zhiben Wetland is often used for other purposes, there are many livestock in the land environment where there is a lot of livestock grazing, and there are unscheduled irregular large-scale fire wetlands. Therefore, our study aims to investigate whether the fire will affect the changes in the composition of bird habitat. This experiment is conducted from March 1st, 2018, and is fixed to the Zhiben Wetland for two consecutive days every week. May 27, 2018 occurred a fire in our study area unexpectedly. After the fire, our study area was divided into the burned area and unburned area. In the unburned zone, we recorded the common birds by line transect method. *Lanius schach*, *Oriolus chinensis*, *Acridotheres javanicus*, *Streptopelia tranquebarica*, *Pycnonotus taivanus*, *Prinia flaviventris*, and *Dicrurus macrocercus* and *Hirundo rustica* are the most common birds and have the largest populations. We found that the number of white-tailed starlings and large-tailed tails was higher in the burned zone, and their activities carried out were mostly foraging; the number of house swallows in unburned areas was high, and the difference between red carp, aconite and gray-headed owl was not significant in the two areas. The yellow scorpion and the brown-backed Shrike are more likely to be in the unburned area than in the burned area, and they prefer to stay at the treetops. The tree species are mostly *Leucaena leucocephala*. We suggest the result is due to the large number of leucorrhea in the unburned area. Rare birds such as *Gallirallus striatus* appear in unburned areas for food or rest. In the area where including fire disturbance, the species and the number of potential prey insects for birds are far below the area where the unburned area compared to burned areas. Because the bird foods such as insects that are lacking the plant-covered burned area are easy to appear and are preyed in burned zone. More aggressive bird species will become dominant species in burned zone, making it difficult for other relatively unaggressive bird species to compete with those birds.

Key Words: *Avian Ecology, Fire Ecology, Plant vegetation ecology, wetlands, disturbance*

負責任的里海海鮮

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摘要

里海是一個新名詞，但是卻是工業時代之前的舊生活方式。現代化過程速度太快，因此環境無法負荷，人群的意識也來不及覺醒，因此造成今天的失衡。今天地球已經有 70 多億人口，對環境的利用方式是不可能依照 100 年前的方式運作，但是徹底檢討過去與現在運用方式的差異，可能可以協助我們找出一個人跟環境間可永續的互動方式。今天人類與海洋最重要的互動之一就是漁業的行為，台灣的文明發展史是創始於漁業行為，漁業也一直對台灣的文明發展扮演重要的角色。雖然常有人說台灣沒有漁業文化只有海鮮文化,但是在 1949 年以前台灣的文化跟海鮮是息息相關的。只是 1949 年台灣的社會經歷了巨大的變化，台灣從一個里海的社會轉成為一個拒海的社會，近年來台灣重新面對海洋時海洋資源已近枯竭，台灣住民對海洋的認知更是破碎。面對這個現況再多的批評及責難都不足以改善，如果我們真正重視重新建構人與海洋的良性互動，就必需找出行動的方式。觀察世界上許多先進國家在推動海洋永續利用的方式,由 NGO 發展的環保標章扮演了非官方的重要貢獻，但是檢視現在的環保標章，卻多是架構於大規模海洋生物資源在貿易型產業利用為主，無法照顧到關係環境及居民的山-河-海生態系利用，而這方面的生活型利用卻是沿海生活的重心。因此本文介紹實際發展地產地消(Local Produced Local Consumed)的供需為服務對象的環保標章案例，藉以推動里山里海的生活方式。

關鍵詞：海洋環保標章、地產地消 LPLC、RFI 責任漁業指標、永續漁業利用

THE RESPONSIBLE SATOUMI SEAFOOD

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Abstract: Satoumi is a new term but an old lifestyle before the industrial age, the modernization had been too fast for the environment to suffer and for the people to aware and cause the imbalance today. There are over 7 billion population in the world today that we cannot utilize the environment in the way 100 years before. However, a thorough review of the differences between how we treat the environment before and now may help us find a sustainable way of interaction with the earth. One of the most important interactions between mankind and the ocean today is fisheries operations. Fisheries plays not only an important role in the Taiwan civilization development but also how modern Taiwan culture first initiate. People often claim that there is only Seafood Culture, not Ocean Culture in Taiwan, but before 1949 Taiwan's culture was closely related to seafood production. The tremendous changes in 1949 actually turn the lifestyle of Taiwan from a marine society to a land society. When Taiwan started to face the ocean again recently, marine resources have been significantly exhausted, and the residents' perception of the ocean is very fragmented. Criticism and blame are not helpful to improve the situation today, the best way to re-construction a healthy marine environment must go through the benign interaction between people and the ocean and take on actions. Observing how advanced countries promoting the sustainable use of the ocean, the Eco-label developed by NGOs has provided an important contribution unofficially. But these Eco-labels is mostly design for serving large-scale fisheries for trading purpose, can hardly serve the "Local Produced Local Consumed" type of small marine resource utilization today. It is important to develop an LPLC type of Eco-Label system that can be helpful for the Satoyama and Satoumi type of communities living.

Key Words: Marine Eco-Label, LPLC(Local Produced Local Consumed), RFI(Responsible Seafood Index), Sustainable Seafood

拯救濕地：綠色衝突的威脅和解方

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摘要

近年來，再生能源的日益發展令太陽能開發與濕地保護兩者產生了衝突。台灣的濕地保育法要求「明智利用」濕地，強調濕地之生態系統服務並兼顧生態環境保護，以制定濕地的管理計畫。然而，目前台灣幾處濕地的太陽光電開發計畫，似乎未對濕地之「明智利用」有適切之理解與採用。本研究以系統性與參與式的方式，嘗試制定濕地之明智利用計畫及最低衝突的再生能源選址框架。其中，透過參與式環境規劃，得以釐清布袋鹽田濕地的生態系統服務及制定出此區之明智利用計畫；而藉由系統性之考量，得以根據生態評估結果，提出布袋鹽田濕地具重要生態價值之區域及對生態與社會影響最小、可能用於發展再生能源的潛在區域。在最低衝突的再生能源選址框架上，本研究以台南及嘉義為研究區域，篩選出濕地及其他生態敏感地區之外，可能發展再生能源之區域。本研究由加州柏克萊大學、奧勒岡大學及國立成功大學共同合作，期望透過跨學科整合，協助解決當今台灣濕地面臨的土地利用問題，並且激勵政府與決策者善用科學來為再生能源發展及濕地經營管理提供依據。

關鍵詞：濕地明智利用、綠色衝突、參與式研究、濕地保育

SAVING OUR WETLANDS: THE THREAT OF GREEN CONFLICTS AND METHODS FOR RESOLUTION

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Abstract: Conflict has emerged between the desire for developing photovoltaic panels and wetland conservation. Taiwan's Wetland Conservation Act calls for "wise-use" of wetlands, a concept based on the ability to create management plans that utilize ecosystem services while maintaining high conservation standards. Now, it seems the term wetland "wise-use" is being misused for justifying development of solar in numerous wetlands around Taiwan. This collaborative research works towards creating and utilizing systematic and participatory processes for the creation of wetland wise-use plans, as well as a systematic framework incorporating top-down and bottom-up approaches for least conflict renewable energy siting. We hope that the utilization of these two interdisciplinary processes can help to resolve land use problems facing Taiwan's wetlands today. We conducted participatory environmental planning to identify ecosystem services and wise-use plans for Budai Salt Pan Wetland, and created a checklist requiring scientific analyses and participatory research for identifying whether or not there are areas in a wetland that could be suitable for renewable energy development, paired with regulations for any development that may occur. We used Budai Salt Pan Wetland as a case study for this checklist and identified areas most critical to protect, and areas with least ecological and societal use that could be considered for renewable energy development. The results show that a large part of current government solar development plans within Budai salt pans are located in areas with high ecological and commun ity value and are not suitable for development. In addition, we created a suitability analyses framework for identifying least conflict areas for development of renewable energy outside of wetlands and other ecological or environmental sensitive areas, using Tainan City and Chiayi County as a case study. Our research spanned across the campuses of three universities, gaining insights from students and researchers during each step. Researchers and students from the University of California, Berkeley focused on the preliminary suitability analyses, then students and researchers from National Cheng Kung University refined and built off these results and had students and professionals working together to conduct field evaluations, interviews, and participatory research. Students and researchers from the University of Oregon then focused on detailed site design. By working within systematic frameworks that can be repeated and used by others, we hope to inspire the government and decision makers to better utilize science in informing development and wetland management decisions.

Key Words: wetland wise use; conflict of greens; participatory research; conservation

城西魚塭濕地水位試驗及水鳥棲地營造

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摘要

城西魚塭濕地位於安南區城西里，台江國家公園城西濕地特別景觀區之範圍內。魚塭原作養殖用途，廢養以後，因魚塭與附近的城西保安林一帶人為干擾少，加上地緣位置鄰近四草及七股的野生動物保護區，遂成為野生動植物利用之棲地，而冬季時，南遷的冬候鳥亦在此停留。過去此區作為養殖魚塭時，所設置之水門與水路連通外圍較大的圳路，可隨海水的漲退潮進行引水及排水。然而，目前未有整體性的經營管理，加上原有之水門擋板已遺失，無法有效調控魚塭地內的水位，根據先前的研究指出可能因此出現水位過深、不適合水鳥利用之情形。為了尋求棲地品質提升的可能性，本研究進行水文、水質、地形等方面的基礎調查，以及透過水門操作試驗調節水位，並搭配水域生態調查，釐清水文與生態之關聯性，再藉以評估區域內棲地品質恢復或提升之可能，期望達成營造擴大友善生物利用棲地之目標。

關鍵詞：魚塭濕地、水位管理、水門操作試驗、棲地營造

EXPERIMENTAL WATER LEVEL OPERATION FOR WATER BIRD HABITAT ENHANCEMENT IN CHENGXI FISHPOND WETLAND

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Abstract: Chengxi fishpond wetland is located in Annan District of Tainan City, a scenic area inside Taijiang National Park. After the fishponds were abandoned, little human disturbance has allowed the ponds to become wetland habitats. With its proximity to Sicao and Qigu Wildlife Reserve, Chengxi fishpond wetland has large potential for birds and other wildlife to utilize, especially for winter migratory birds. When the land was used as fishponds, water gates controlled the inflow and outflow of water from the channel. Now, as the many of the water gates have either gone missing or been damaged, water levels are unable to be managed. Previous research have implied that this lack of water management leaves the water level in the Chengxi ponds unstable and often too high for birds to rest or forage. In order to investigate possibilities of improving the habitat quality, we conducted water gate operation experiments informed by environmental surveys collecting topography, water quality, and hydrology data, and paired with ecological surveys of bird, fish and benthic organisms. The goal of these experimental water gate operations is to clarify the relationship between hydrology and ecology and assess the possibility of restoring or improving the habitat quality in Chengxi wetland in order to increase habitat diversity for water birds.

Key Words: fishpond wetland, water level management, water gate operation experiment, habitat enhancement

志工參與雙連埤濕地水生植物復育前期之原地保種及棲地復原試驗

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摘要

雙連埤濕地及周遭地區在 1990 年代曾記錄到 100 多種的水生植物，其中有 10 餘種於台灣維管束植物紅皮書被列為珍貴稀有物種。在 2001-2002 年間，雙連埤濕地因前地主之疏浚與築堤、放養外來經濟魚類等因素，導致大量水生植物消失。2016 年荒野保護協會結合具社會責任的企業、志工以及民間團體 (NGO) 資源，進行濕地水生植物復育之前期工作，包含原地保種與棲地復原試驗兩項工作。

原地保種是針對稀有或族群數量明顯下降之水生植物於湖域出水口附近的公有地旁透過志工人力，營造了數個水池進行水生植物原地保種，除了移植回早期異地保種地植物外，且因挖掘過程中，攪動到土壤較下層的種子庫，重新長出數種已經消失近 16 年的珍稀水生植物，如日本菱 (Trapa japonica)、小果菱 (Trapa incisa)、蓴菜 (Brasenia schreberi)、田蔥 (Philydrum lanuginosum) 及絲葉石龍尾 (Limnophila sp.) 等等。棲地復原實驗則參考前人所做的種子庫、棲地改善實驗及當地的水文地形資料，選擇在雙連埤東北側以人工方式將堤岸改變回原始棲地樣貌以進行水生植物復育。棲地復原實驗包括兩種處理方式，一是將堤岸恢復成淺灘地，二是在恢復成淺灘地時，於灘地及湖水水域交接處保留帶狀隔離區，以阻隔外來種魚類入侵。結果顯示兩種處理皆有許多原生水生植物重新出現，但沒有保留隔離帶之淺灘地，許多水生植物長出不久後又消失，推測可能與外來種魚類的啃食有關。由於先前人為擾動的影響，雙連埤的棲地可能已不適合直接恢復成原始棲地的樣貌，建議未來在規劃棲地復原時須考量外來種生物之影響。

關鍵詞：雙連埤、棲地復原、志工參與、原地保種、水生植物

VOLUNTEER-PARTICIPATED EARLY-STAGE AQUATIC PLANT RESTORATION : *IN-SITU* CONSERVATION AND HABITAT RESTORATION EXPERIMENT IN SHUANGLIANPI WETLAND, NORTHEASTERN TAIWAN

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Abstract: In the 1990s, more than 100 aquatic plant species have been recorded at the Shuanglianpi Wetland, northeastern Taiwan, and its surrounding area. Among them, more than ten species are listed as "rare and special species" in The Red List of Vascular Plants of Taiwan. However, those aquatic plant decreased in population size and species diversity between 2001 and 2002, because of the sudden changes of the habitats by the diking activities and exotic farmed fish cultivation of the former land owner. The Society of Wilderness (SOW), combined with companies with corporate social responsibility, volunteers, and NGO resources, stepped in the early-stage aquatic plant restoration, including *in situ* conservation and habitat restoration.

The *in situ* conservation, focusing on the rare aquatic plants and native species with a significant decline in population size, with the aids of volunteers, several pools were built near the wetland water outlet and several *ex-situ* conserved plants were transplanted back. During the excavation process, several rare aquatic plant species were also naturally recolonized from the seedbank, that have not been spotted in this wetland over 16 years, such as *Trapa japonica*, *Trapa incisa*, *Brassica schreberi*, *Phelidrum lanuginosum*, and *Limnophila* sp., *et al*. The habitat restoration experiment was conducted at the northeast shore of the wetland according to the previous studies on seedbank, habitat improvement experiments, and hydro-geomorphology in the wetland. We restored the artificial steep levee back to the natural shoal form by man power. Two different treatments were applied in the experiment to test the effect of invasive fish on plant restoration. One treatment we only restored the shoal to its natural form, and the other treatment we retained a shallow levee between the restored shoal and wetland as an isolation zone to prevent invasive fish. The results showed natural recolonization of many native aquatic plants in both treatments, but the restoration in shoal without isolation zone was not as successful because many aquatic plants died soon after they emerged. We hypothesized that this might be the result of foraging by invasive fishes. Because the animal community structure in Shuanglianpi Wetland has changed, the conservation of Shuanglianpi Wetland back to its natural form may not be ideal. It is required the consideration of the influences from the invasive fish species for future conservation planning and aquatic plant restoration.

Key Words: Shuanglianpi wetland, habitat restoration, volunteer-participated, *in-situ* conservation, aquatic plants

大崙尾山翠山步道線物候調查

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摘要

本文探討 2011 年至 2018 年荒野保護協會於士林大崙尾山區，進行之木本植物為主的定期生長紀錄。該樣區位於距離故宮十分鐘車程，與陽明山國家公園隔溪相望。由於邊坡下方有崁腳斷層通過，地質不利於大規模開發，故人為干擾少，加上長年東北季風影響，因此造就出高度豐富生物多樣性的次生林。然鑒於希望了解氣候變遷對棲地生態之影響，定期的物候紀錄因此應運而生。我們根據在地關鍵性木本植物、在地優勢原生種、全台普遍樹種、北降植物等指標，選定了光葉柃木、大明橘、筆筒樹、香楠、山豬肉、台灣楮等數十種植物，進行逐月記錄其葉花果之生長情況。再以數字 0 到 4，來代表不同的生長狀況。以葉為例，將其分為空枝(0)、嫩芽(1)、新嫩葉(2)、老葉(3)、落葉(4)；花則分為花芽(0)、膨大(1)、開花(2)、盛開(3)、終花(4)；果實則分為增大(0)、始熟(1)、正熟(2)、過熟(3)、掉落(4)。初期每月定期紀錄近五十處植株，之後則擴大為七十處，2016 年則擴大至兩個樣區。第一個樣區，特點是是面風的山腰，第二個樣區則是面風的山稜線。就本團隊的調查結果，與全球暖化的關聯性，因資料累積的時間尺度及樣本數仍有不足等因素，仍難有結論，但就其葉花果生長狀況而論，確實其氣候變化具有或多或少之影響力。

關鍵詞：東北季風、次生林、北降植物、氣候變遷、物候

PHENOLOGY SURVEY OF XISHAN TRAIL, MT. DALUNWEI

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Abstract: The article attempts to analyze the periodical observational records of woody plants collected by SOW in Mt. Dalunwei in Shilin District during 2011-2018. The sample area is located 10 minutes' drive away from National Palace Museum and parted by river with Yamingshan National Park. With Kanjiao Fault passing beneath, the unstable geology protects the area from big-scaled urbanization as well as human interference. In addition, the Northeastern monsoon which constantly blows the area has created secondary forest with rich abundance of biodiversity. However in order to understand how climate change has impacted the habitat ecology, ongoing efforts for phenological records are required. We have selected dozens of targeted plants from critical woody plants, predominated native plants, common plants island wide and the plants of lower-altitudinal distribution. These targeted plants include Common Eurya, Sequin Myrsine, Common Free Ferm, Zuiho Machilus, Meliosma oldhami and Island Ash. Every month, their growing condition like leave, flowers and fruits are observed and marked by 0-4 representing different growing stages. Take leaves as an example, 4 stages will be recorded – 0 stands for none, 1 for sprout, 2 for new leaf, 3 for old leaf and 4 for falling; same for flowers, bud (0), expanding (1). blossom (2) blooming (3) withering (4); fruit – expanding (0), initial riping (1), riping (2), over riping (3), falling (4). During the initial phase, plants of approx. 50 sites were recorded monthly, then expanded to 70 sites and eventually stretched to two sample areas in 2016. One of the sample area is on a windward hillside while the second one is on a windward ridge line. The analysis result of the survey doesn't provide substantial evidence to conclude the impact of climate change on the ecology because of limited time span and sample size. However, it helps to reveal that changes of weather in specific periods did impose some impact on the growing conditions of leaves, flowers and fruits.

Key Words: Southeastern monsoon, secondary forest, lower-altitudinal distribution plants, climate change, penology

諸羅樹蛙棲地保育與友善農耕之鏈結實作

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摘要

本文探討 2014 年 7 月至 2018 年 6 月間，荒野保護協會執行「諸羅樹蛙棲地保育計畫」，藉以推動友善農耕與諸羅樹蛙棲地保育之過程及成果。諸羅樹蛙主要分布在嘉義、雲林、臺南一帶的竹林、果園、低窪積水處，近年來受棲地碎裂化、環境污染、土地開發、耕作型態改變、氣候變遷等影響，諸羅樹蛙之生存危機與日俱增，故希望藉由友善農耕方式，實質圈護農田生物棲地，並搭配生態調查與棲地環境改善工作，達到生態、生活和生產「三生共贏」之目標。藉由農地契作推動友善農耕，契作地點位於嘉義縣溪口鄉「諸羅紀農場」，包含芭樂園和竹林，總面積約一公頃，且臨近三疊溪，可與周邊濱岸灘地及林木區形成一有助於諸羅樹蛙遷徙利用之生態廊道。保育計畫主要工作項目包含：竹林生態調查、無毒竹筍和芭樂契作生產、竹林棲地改善復育、農事體驗工作假期等。本計畫透過募款方式籌措執行經費，捐款者享有優先參與農事體驗工作假期及農產品之分配。計畫執行期間共計調查到蛙類 8 種（諸羅樹蛙、澤蛙、貢德氏赤蛙、中國樹蟾、小雨蛙、白頷樹蛙、黑框蟾蜍、面天樹蛙）、鳥類 51 種及其他多樣物種，相較於本計畫執行前，無論種類及數量上皆呈現增加趨勢，同時亦發現周遭適合諸羅樹蛙生存的農地，多有諸羅樹蛙棲息。另因耕作模式處於友善農法轉型期，病蟲害肆虐及風災之影響，加上採契作方式，所可能導致之田間管理積極度不足，整體農產量呈下降趨勢。此外，農場每年有數百人參與農事體驗活動，並吸引相關媒體報導，成功形塑良好環境教育場域，也為村莊帶來活力氣息。為一成功地鏈結友善農耕與諸羅樹蛙棲地保育之實作案例。後續「諸羅樹蛙棲地保育計畫」將回歸由當地社區執行，朝向「三生環境教育基地」發展，並逐漸擴大影響範圍，增加友善農耕之操作面積，以兼顧農業生產經濟價值與優質且健康的農村生活，進而打造人與野生動物共有共好的生存環境。

關鍵詞：諸羅樹蛙、棲地保育、諸羅紀農場、友善農耕、三生共贏

THE LINK AND IMPLEMENTATION BETWEEN ZHULUO TREE FROG HABITAT CONSERVATION AND ECO-FRIENDLY AGRICULTURE

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Abstract: This article probes the process and result of "Zhuluo Tree Frog Habitat Conservation Program" which combines eco-friendly agriculture and habitat conservation, be carried out by The Society of Wilderness from July 2014 till June 2018. Zhuluo tree frogs can be found at bamboo forests, orchards and puddles in Jiaiyi, Yunlin and Tainan counties. Due to habitat fragmentation, pollution, land development, agricultural style change and climate change, the Zhuluo tree frogs face ever growing threats of their existence. Therefore, this program is aim to use eco-friendly agriculture, to encircle farm land physically as habitat, to conduct ecology survey to improve the environment in order to reach the Three-Win of Ecology, Life and Production. Through contract farming to promote eco-friendly agriculture, the selected farm land is called "Zhuluo Farm" locates at Xikou village in Jiayi county; with over one hectare of space that includes a guava garden and a bamboo forest; it is next to the Sandie creek. Combined with the surrounding muddy land and forests, it forms an ecological corridor suitable for Zhuluo tree frog's migration. The major tasks of this conservation program include: investigation of bamboo forest ecology, contract farming of organic bamboo and guava, improvement of bamboo forest habitat and farming-experience working holiday. Funds are raised to support this project. All donors are entitled with priority to participate experience farming and to receive farm produces. A total of eight frog species (Zhuluo tree frog, Rana limnocharis, Rana guentheri, Hyla chinensis, Microhyla fissipes Boulenger, Brauer's tree frog, Duttaphrynus melanostictus, Kurixalus idiootocus), 51 bird species and other species were documented during this project which proves its bio-diversity. As compared with the findings before executing this project, the numbers of species and their quantities have both increased. In the meantime, Zhuluo tree frogs were found at surrounding farm lands suitable for them. However, the overall harvest dropped due to the early stage of eco-friendly farming transformation, effects of plant diseases, insect pests and wind storms, and lack of active management caused by contract farming. Besides, hundreds of people participated farming activity and media was attracted to report such a successfully example which combines eco-friendly farming and Zhuluo tree frogs habitat conservation as an environmental education ground. Village embraces this new energy. To continue this "Zhuluo Tree Frog Habitat Conservation Program", local community will take over, develop toward "Three-Win of Ecology, Life and Production Environmental Education Base", expand its influence, and increase its eco-farming area for a more economical, better and healthier farm life. Finally, we try to build an environment both for human and animal to co-exist.

Key Words: *Zhuluo tree frog, Habitat protection, Zhuluo Farm, Eco-friendly farming, Three-Win of Ecology, Life and Production*

臺北市榮星花園公園生態水池棲地再生復育

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摘要

本復育活動係荒野保護協會參與榮星公園生態池的改造計畫。榮星公園內原有農田水圳流經其間，該生態池是早期水道的尾端，出水口有緩慢而流動的活水，因該池域有近一層樓高的天然土堤，得以阻絕光害，成為黃緣螢固有生育棲地，這處得天獨厚的溼地，迭歷各種都市開發行為，因緣際會的保持著原始的風貌。近年來，因外來種的入侵和水質的汙染，生態環境逐漸劣化，成為充滿垃圾、鼠輩蚊蠅滋生的惡臭水塘，荒野保護協會從2014年始展開對外與對內的推展協調，串聯臺北市政府、在地里長與里民及鄰近學校的資源；分別進行「棲地營造」、「推廣教育」、「攝影紀錄」三個工作項目，自 2015 年起，以工作假期的模式，召集市民共同參與，進行外來種清除及微棲地營造，並搭配生態水池周邊改善如循環水設備裝置、燈光改善、綠圍籬植栽等復育流程，創造水質自然淨化，並可提供生物棲息的生態環境。在友善土地的精神下以不使用大型機具全程人工進行施作，分區分次的完成棲地營造，使之成一個更合適螢火蟲棲息的環境，在參與的過程中，讓參與者學習棲地守護的教育內涵，以公部門及社區合作協力進行公園棲地復育，成為落實公民參與的典範。迄今仍持續進行在地志工隊培訓，推動在地居民成為公園巡守、維護環境的持續力量，並影響更多都會公園也可以朝向生態公園管理模式規劃，讓公園形成豐富的生態環境，更期待將正確的生態觀念擴及當地民眾，以達成在地守護、公民參與的目標，更提供民眾親近自然又可兼顧維護自然棲地環境的途徑，逐步實現都市公園生態化的願景。

關鍵詞：榮星公園、螢火蟲、棲地營造、公園生態化、公民參與

RESTORATION PROJECT OF AN ECO-POND AT RONGXING PARK, TAIPEI CITY

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Abstract: This project was an act to reform a pond at RongXing Park sponsored by the Society of Wildness. The Rongxing Park used to be a farmland at the edge of Taipei city. The pond in the park was a reservoir of natural waterway which flown through from the south-east. To the day, flow of underground water still streams into this pond. On the south side a nature embankment around one-floor high provides nice shade to the pond. Thus existed Aquatica ficta (a species of firefly found only in Taiwan and parts of China) stayed reproducing in this habitat. With disturbance of more and more alien species and pollution to the water, the pond was eventually taken over by smelly trash and environmental pests. Some members in the Society Of Wildness initiated this project in 2014 to restore this habitat for Aquatica ficta(黃緣螢 fireflies), build an educational case of ecological restoration, and document the progresses on the film; started with promoting and lobbying the idea to its own organization and volunteers, the government officials, chiefs of the villages, residents in the neighborhood, and schools nearby. In 2015 the restoration was set in motion, a series of work holidays were hosted by the Society of Wildness. Volunteers came in the park, got into the pond to remove objects that should not belong there week by week until the microhabitat was restored. Meantime, improvements were made to the water circulation system, lighting in the park, hedgerow surrounded and so on. An unpolluted and living-creature friendly habitat was framed. To ensure environmental friendly, no machine tools were adopted throughout the process but only manual application. Volunteers went through various stages to complete the restoring development, and conducted a healthy habitat for the Aquatica ficta (fireflies). During the process, participants learned the value of protecting habitats; with collaboration of government and society, this implement set a model of public participation. A team of local guardians were formed since, and continuous training were provided to enforce on-going protection to this environment. Hoping this project would urge the ecologicalization to more urban parks, inspire people to protect environments around them, encourage public participation in subject matter, bring nature to the city life without sacrificing the habitat, and gradually achieve the vision of urban park ecologicalization.

Key Words: Rongxing Park、firefly、habitat management、urban park ecologicalization、public participation

新竹油羅田生態保育之實地操作計畫

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摘要

本文探討荒野保護協會新竹分會於新竹油羅租地進行友善自然生態的無毒農法種植，導入自然生態系統平衡功能，實地操作種植稻米蔬菜。由於慣行農法盛行，間接影響到荒野、低海拔山區的自然生態。荒野保護協會一直想要鼓吹農人施行友善自然萬物的無毒農法。油羅位於新竹縣橫山鄉豐田村，是一個傳統的客家農村聚落。因緣際會，荒野新竹分會自 2014 年起在油羅承租了原來已休耕多年的農田與菜園，逐步摸索種植稻子與多種根莖葉菜類蔬菜，施行友善自然生態的無毒農法，包括在農田菜圃及鄰近區域施行草根栽培、人工除草/割草。利用黑水虻來分解廚餘、加上自然野地腐殖壤土裡豐富的真菌、酵母菌製作堆肥，利用蜜糖水加豆渣、米糠製作伯卡西肥。在我們尚未能自給足夠改善土壤土質所需的自製有機肥前，我們也外購有機肥。另外，為因應極端氣候，降雨不均，我們正在進行滴灌的實驗，將來希望能與雨撲滿結合。此外，我們也企圖廣泛利用自然生態服務，來達到農業害蟲控制，包括絕不使任何農藥、除草劑，希望能漸漸恢復生物多樣性。2018 年 4 月開始設置獨居蜂旅館，其中包含一個方便觀察的精美獨居蜂旅館，還有數捆用竹條自製的簡易型獨居蜂旅館。2018 年 6 月設置貓頭鷹巢箱，由於設置時日尚短，成效有限。油羅生態保育到目前為止，已經觀察到的效果包括挖掘翻土時，經常發現蚯蚓、螞蟻、千足蟲、小甲蟲，菜園網架上有長腳蜂來此築巢，蜂旅館已觀察到日本藍泥蜂入住，貓頭鷹巢箱也意外觀察到長腳蜂入住。新竹油羅田成功的實地操作生態保育計畫，可作為其他田地進行生態保育之參考。

關鍵詞：荒野油羅田、蜂旅館、廚餘堆肥、棲地營造、公民參與

THE NON-TOXIC AND FRIENDLY FARMING FOR ECOLOGICAL CONSERVATION IN YOULUO OF HSINCHU COUNTY

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Abstract: This study presents a case of planting rice and vegetables using non-toxic and friendly farming. SOW (the society of wilderness) rents a land in Youluo, importing the balance function of natural ecosystem, planting rice and vegetables. Because the prevalence of conventional farming has indirectly impacted the ecosystem of wilderness and low-altitude mountainous areas, SOW has been advocating farmers to conduct non-toxic farming which is friendly to the natural; however, it is necessary to prove the feasibility and that it won't be detrimental to the market competitiveness, then there will be enough factual support to convince the farmers. Youluo located in Fengtian Village in Hengshan Township, Hsinchu County is a traditional Hakka rural community. Since 2014, SOW rent the originally fallowedfarmlands, and has gradually explored the non-toxic farming method of rice and various roots and leaves vegetables, including conducting manual weeding/mowing and grassroots cultivation in farmlands and nearby area. We used Hermetia illucens to decompose the kitchen waste, used yeast and fungi from natural humus loam to make compost, and used sugar water added bean dregs and rice bran to make Bokashi fertilizer. We also buy organic fertilizer before we can self-supplement the homemade fertilizer. Furthermore, in response to extreme weather, we are now conducting drip irrigation experiment hoping to combine it with rainwater tank. We also attempt to make use of ecosystem service to control agricultural pests, for example, refuse using any pesticides or herbicides, hoping to gradually restore the biodiversity. Since April 2018, we have been planning to set " solitary bee hotels" including a beautiful one for easy observation, as well as several simple ones made with bamboo strips. Since June 2018, we have been planning to set owl nest boxes, but the effectiveness was limited due to short setting time. The achievements until now include earthworms, ants, millipedes, and small beetles appeared when digging the soil, Polistes bees built nests on the vegetable grids, Chalybion bengalense inhabited in the bee hotels, and the Polistes bees surprisingly be found inhabit owl nest boxes. This successful case can be used as a reference for ecological conservation in other fields.

Key words: SOW Youluo farm, bee hotel, food waste compost, habitat creation, civic participation

關渡自然公園棲地營造對鳥類的影響

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摘要

關渡自然公園位於北臺灣的淡水河及基隆河的交界處，由埤塘、泥灘地、草澤、水稻田及樹林等棲地組成。這片濕地曾經在 20 幾年前遭受不肖人士傾倒垃圾及廢土，進一步造成棲地的陸化及劣化。為了恢復原有豐富自然生態，於 1998 年起各項棲地改善工程陸續開始動工，並同時開始進行關渡穿越線鳥類監測，每年沿固定的路徑進行 19 次穿越線調查，記錄 9 個分區的鳥種及數量，至 2017 年已持續了 20 年。本研究以此資料檢視棲地改善工程及後續的棲地維護是否有達到改善水鳥棲地的目標，將所記錄到的鳥種，依其在關渡自然公園利用的棲地類型分為 7 個生態同功群，藉由分析各別同功群在不同分區歷年的隻次比例變化，並配合航拍照片計算各分區不同棲地類型的面積比例，藉以比較棲地改善工程對鳥類組成及數量的影響。結果顯示關渡的棲地改善工程在增加水鳥的數量及鳥種數上有正相關。

關鍵詞：棲地管理、生態同功群、水鳥, 關渡

THE EFFECT OF HABITAT CREATION ON BIRD NUMBERS IN GUANDU NAUTRE PARK

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Abstract: Guandu Nature Park is situated at the junction of Tamshui River and Jilong River in northern Taiwan. The Park consists of habitats such as ponds, mudflats, marshes, paddy fields and forested areas. Two decades ago, the dumping of garbage and waste soil further caused terrestrialization of the wetland and overall degradation of habitat. In order to restore the wetland to its original state, various habitat improvement projects began in 1998. At that time, a routine bird survey was established and continues till today. The bird survey is conducted along a fixed transect line, recording bird species, their numbers, habitat type used and the section of the Park observed. The survey is carried out nineteen times per year. This study uses data from the survey to examine whether habitat improvement projects and subsequent habitat maintenance have improved waterfowl habitats. Then to determine whether or not the effects of habitat improvement projects had a positive effect on bird composition and numbers, birds are divided into seven ecological guilds according to the types of habitat they use at the Park, and aerial photographs are used to calculate the area and proportion of different habitat types. Comparisons were done on changes in the proportion of guilds over the years in the different sections of the Park, and also to the changes in the ratio of different habitat types within different sections. The results indicate that there is a positive relationship between the habitat improvement projects to the increase in waterfowl numbers and diversity in the Park.

Key Words: habitat management, ecological guild, waterfowl, Guandu

從棲地復育看生態心理學之實作串聯

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摘要

本文探討以生態心理學式的引導方案，藉由棲地復育工作串聯至個人療癒與社區重生的過程。生態心理學是由 20 世紀末期的一群心理衛生工作者並且關注環境危機的學者所提出，基於近數十年來人類對賴以為生的土地濫墾濫伐、污染水源及空氣的現象，生態心理學不只是探究人類為何會破壞環境的心理因素，也積極的尋求其改善之道的實務應用。生態環境保護的範圍包括了動植物及山川大地，亦是一場大規模的全球議題，故與每個人都息息相關，因此生態心理學者指出其關鍵乃在「人心」。荒野保護協會自 2012 年起連續七年辦理生態心理學志工培訓，試圖創造生態界與心理界的二造人馬一起從事生態環境保護工作的可能性。部份夥伴在結訓後，於三芝、宜蘭等地從事友善農耕工作，幾年下來，從他們的身上漸漸看到持續而深刻的改變，包括尊嚴感及歸屬感、對多樣性的包容力，以及對永續生態的感受性。在農田中做著重複而勞務性的工作卻能得到正向的回饋；而在農忙時期社區中的換工或打工換宿的過程中，即使不同的年齡、族群都自然地形成互動配合的小團隊，進而擴展關注整個區域的生態網是否健康。這個對區域生態網友善的棲地復育工作，本身就具有療癒及更新的效果，可以做為個人與社區重生的借鏡。相反地，若是以強制性及速成的心態介入棲地復育，往往會殘害棲地本來具有的及有益的復原力，同樣的狀況亦可見於個人的成長及療癒過程，這也是生態心理學中綠色照護的隱憂之一。以少數個人在農地進行棲地復育的案例，對照整體環境被大規模破壞的狀況似乎是微不足道，但卻提供了有利全人類健康而可努力的願景，以及參與棲地復育的協力合作經驗。期望可以從單點串聯成全面性的生物棲地、個人及社區永續健康生態網絡。

關鍵詞：棲地復育、生態心理學、綠色照護

APPLICATION OF ECOLOGICAL PSYCHOLOGY IN HABITAT RESTORATION

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Abstract: This study explores implementation of an ecological psychology-base guiding program. The program is used in a process of linking personal healing and community regeneration by doing habitat restoration work. Ecological psychology was proposed by a group of mental health workers and scholars concerning environmental crises in the late 20th century. In recent decades, human have seriously destroyed the land we lived on, polluted the air and water we lived with; therefore, ecological psychology not only explore the reasons human destroyed environment, but also actively seeks practical application of its improvement. The scope of ecological and environmental protection includes animals, plants, mountains and rivers. It's a large-scale global issue, closely related to every human being; therefore, ecological psychologist pointed out that "people's mind" is the most important point. SOW (The Society of Wilderness) has been conducting ecological psychology volunteers training for seven years since 2012, trying to create the possibility that ecological and psychological communities work together to practice ecological and environmental protection. Some of our participants engaged in eco-friendly farming in Sanzhi and Yilan after training. Several years later, we discovered continuous and profound difference in their characteristic, including sense of dignity, belonging, inclusion of diversity, and the susceptibility to the sustainable ecosystem .Doing repeated and labor-oriented work in the farmland can get positive feedback; carrying out community work exchange can get people naturally form cooperating team despites of different ages and ethnic groups, and then the focus has been further expanded on the entire region's ecosystem health. The eco-friendly habitat restoration work is efficiency in healing and renewing this region, which can be used as an example for personal and community recovery. On the contrary, if the restoration was done mandatorily or hasty, the habitat's inherent resilience will always be damaged, the same situation can also be seen in the individual's learning and healing process, which is one of the hidden concerns of green care in ecological psychology. Such case with small number of individuals seems negligible for the large-scale destruction against the entire environment, but it provides a vision that is conducive to the health of all human beings and a collaborative experience of participating in habitat restoration. It is expected that the animal habitats, the people, and the communities can be linked from a single point to a comprehensive and sustainable healthy ecosystem.

Key Words: habitat restoration, ecological psychology, green care

海岸林地占用魚塭收回多元復育之研究

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摘要

本研究以多元復育之植栽方式，於台南濱海防風林內占用收回之魚塭後其林地進行復育試驗，以加速恢復生態環境及營造濕地物種生存環境為目標，規劃各項適地適性的處理配置模式。包括依濕地環境地形不同，共採取塭岸複層林、親水植栽、人工浮島混植試驗等方法。塭岸複層林以木麻黃(*Casuarina equisetifolia* F.)、黃槿(*Hibiscus tiliaceus* L.)及土沉香(*Excoecaria agallocha* L.)進行施肥處理比較；親水植栽以美植袋栽植土沉香、水筆仔(*Kandelia obovata* (L.) Druce)、紅海欖(*Rhizophora stylosa* G.)、苦林盤(*Clerodendrum inerme* (L.) Geartn)、海茄苳(*Avicennia marina* (F.) Vierh)及欖李(*Lumnitzera racemosa* W.)於魚塭邊緣，以期增加綠蔽範圍;人工浮島採用水筆仔、紅海欖、黃槿及土沉香於浮島上栽植，並設置 5 種不同程度配置模型。三項復育措施結果顯示，具有早期恢復生長之效果，塭岸複層林之木麻黃於集約施肥處理之苗高(增加 39.76 ㎝)與基徑生長(增加 0.78 ㎝)上有顯著影響($p<0.05$)；親水植栽試驗結果顯示，樹種間之存活率有顯著差異，以欖李及土沉香兩者達到 70 %以上之存活率；人工浮島混植試驗結果顯示，混植程度越高時，苗木生長效果越佳。於試驗期間也發現周圍動物及昆蟲對溼地復育工法的利用，如紅冠水雞(*Gallinula chloropus*)選用浮島作為繁殖棲所，於浮島栽植樹種上發現臺灣黃毒蛾(*Euproctis taiwana*)與小白紋毒蛾(*Orgyia postica*)等幼蟲出現。

關鍵詞：人工浮島、魚塭、多元復育、美植帶、濕地

THE FISHPOND AFFORESTED BY MULTIPLE PLANTS IMPOSING OF THE COAST FOREST

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Abstract: In this study, the multiple planting methods were used to reforest the fishpond in the Tainan coastal windbreak forest, aiming at accelerating the restoration of the ecological environment and creating the living environment of the wetland species, and planning various suitable configuration modes. Depends on the variety of the topography in the wetland, we set three kinds of different treatments, which include multistoried forest, waterfront area, and artificial floating island. Comparison of fertilization treatments with *Casuarina equisetifolia* F., *Hibiscus tiliaceus* L. and *Excoecaria agallocha* L. at multistoried forest; Root control bags are used in waterfront area. *Kandelia obovata* (L.) Druce, *Rhizophora stylosa* G., *Clerodendrum inerme* (L.) Geartn, *Avicennia marina* (F.) Vierh, and *Lumnitzera racemosa* W. are planted around the fishpond, aiming at increasing green cover. *Kandelia obovata* (L.) Druce, *Rhizophora stylosa* G., *Hibiscus tiliaceus* L., and *Excoecaria agallocha* L. are planted at artificial floating island with five different kinds of mixed modes. The results showed that intensive fertilizer management had a significant effect($p<0.05$) on the growth rate of height(average increase 39.76 cm) and base diameter(average increase 0.78 cm) of *Casuarina equisetifolia* F. multistoried forest. The result of root control bags showed that there was a significant different in the survival rate between different species of trees after 1 year. The survival rate of *Lumnitzera racemosa* W. and *Excoecaria agallocha* L. is more than 70 %. In the experiment of artificial floating island, we found that the higher the degree of mixing, the better the plant growth. The use of surrounding animals and insects to reforest wetlands was also discovered during the experiment. *Gallinula chloropus* chooses the artificial floating island as breeding habitats. The larvae of *Euproctis taiwana* and *Orgyia postica* were also found on the planted trees at artificial floating islands.

Key word: artificial floating island, fishpond, multiple restoration, root control bag, wetland

瓊崖海棠種仁萃取物性質與抗氧化活性分析

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摘要

本研究使用台灣海濱、濕地常見之瓊崖海棠果實作為研究材料，於果實成熟後收集，以不同極性溶劑萃取種仁之油脂與天然物等，並進行脂肪酸組成分析、光譜分析與抗氧化活性測試等，藉以評估瓊崖海棠種仁成分多元利用之潛力與高附加價值研發應用。瓊崖海棠(*Calophyllum inophyllum*) 屬藤黃科，主要分布於太平洋各島嶼等之沿海地區，而在台灣主要做為行道景觀樹種之一，鮮有其他利用。瓊崖海棠果實經採集後乾燥、粉碎，以不同極性溶劑採超音波震盪萃取法，分離、純化後不同萃取層分別以光譜儀(UV-Vis、FTIR)辨別其光譜特徵吸收性質，以及藉由總黃酮量、總還原力、自由基清除能力(DPPH)、氧化自由基吸收能力(ORAC)等試驗評估萃取物其抗氧化與清除自由基能力。萃取物經紫外光譜分析於 280~320 nm 有顯著的吸收，瓊崖海棠種仁油經甲酯化後，由氣相層析儀(GC-FID)分析得知油脂之飽和脂肪酸含量約 23~38%，不飽和脂肪酸含量約 60~75%；總黃酮量 161.7QE(mg of Quercetin equivalent/ g)；DPPH 自由基抑制率 99%，顯示瓊崖海棠除油脂使用外，具有應用於其他層面之潛力。

關鍵詞：瓊崖海棠、脂肪酸組成、自由基清除、抗氧化

ANALYSIS OF THE PROPERTIES AND ANTIOXIDANT ACTIVITY OF EXTRACTS FROM SEEDS OF *CALOPHYLLUM INOPHYLLUM* IN TAIWAN

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Abstract: This study used seeds of *Calophyllum inophyllum* which is commonly seen in Taiwan seashore and wetlands as material. The *C.inophyllum* seeds were extracted with different solvents after-ripened, then used fatty acid composition analysis, spectral analysis and antioxidative activity test etc. to evaluated the potential of multi-utilization and the high value-added application of *C.inophyllum* seeds components. *C.inophyllum* belongs to the genus *Calophyllum* (*Clusiaceae*) which is widely distributed in coastal areas of Pacific islands, and it is mainly used as one species of the street trees in Taiwan, rarely be utilized. In this study, C.*inophyllum* seeds were extracted by ultrasonic extraction method in different polar solvents after dried and pulverized, then separated and purified the extractives before distinguished their spectral characteristics by spectrometer(UV-Vis, FTIR), and evaluate the antioxidative activity and free radical scavenging activity of extractives by total Flavonoids, total reducing power, free radical scavenging capacity (DPPH), and oxidative free radical absorption (ORAC). The extractives had a significantly absorb at 280~320 nm in ultraviolet spectral analysis, further, the esterified C.*inophyllum* seeds oil was analyzed by gas chromatography(GC-FID), and the results showed that the saturated fatty acid content of oil was about 23~ 38%; unsaturated fatty acid content was about 60~75%; total flavonoids was 161.7QE (mg of Quercetin equivalent / g) and 99% of DPPH free radical inhibition rate. As mentioned above, the application of C.*inophyllum* has not only on seeds oil but also on more other aspects.

Key Words: *Calophyllum inophyllum, fatty acid composition, free radical scavenging, antioxidant*

臺灣與鄰近島嶼海茄苳族群遺傳結構之研究

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摘要

海茄苳 (*Avicennia marina* (Forsk.) Vierh.) 為馬鞭草科(Verbenaceae)海茄苳屬(Avicennia)植物，分佈於舊熱帶地區。在臺灣與鄰近島嶼中見於台灣、金門、香港及日本西表島等地，屬正紅樹類 (exclusive mangrove) 植物。本研究以取自台灣、金門、烈嶼、香港及日本西表島等共 4 個地區，12 個族群，計 144 個海茄苳樣株，應用簡單序列重覆分子指紋技術(Inter-simple sequence repeat, ISSR)，來探討臺灣與鄰近島嶼海茄苳族群之遺傳結構及族群間親緣關係，共使用 8 個引子，獲得 80 個條帶，其中多型性條帶有 73 個 (91.3%)，單型性條帶有 7 個 (8.7%)。POPGENE 分析結果總基因歧異度 (H) 為 0.2982，族群間之遺傳分化係數 (Gst) 為 0.5464，基因流 (Nm) 為 0.2076。經族群分子變方分析 (Analysis of Molecular Variance, AMOVA) 結果，島嶼間之變方成分為 39.66% ($p < 0.001$)，島嶼內族群間之變方成分為 19.00% ($p < 0.001$)，族群內個體間之變方成分為 41.34% ($p < 0.001$)，顯示在不同島嶼與族群間已有分化趨勢。依歸群及主座標分析結果可區分為 3 大群，其中臺灣族群為一群；金門、香港的族群為另一群；日本西表島的族群自成一群。依 Mantel test 結果顯示，族群間地理距離與遺傳距離具顯著正相關($r = 0.63$，$p = 0.01^{*}$)，符合距離隔離模式，推測是自然散布之結果。綜言之，海茄苳族群基因流傳並不暢通，不同島嶼間已有分化現象，推測應受島嶼區隔與人為破壞之影響，導致基因流受阻所致。建議除需採取就地保育之措施來保存所有族群外，並應進行遷地保育措施。

關鍵詞：海茄苳、遺傳歧異度、基因流、遺傳變異

POPULATION GENETIC VARIATIONS OF AVICENNIA MARINA IN TAIWAN AND ON NEARBY ISLANDS

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Abstract: *Avicennia marina* (Forsk.) Vierh. belongs to the genus Avicennia (Verbenaceae). It is widely distributed in the old tropical region and can be seen in Taiwan and its nearby islands, such as Taiwan, Kinmen, Hong Kong, and Iriomote-island. The amount of this species of exclusive mangrove is rather limited now. In this study, ISSR markers were used for studying the genetic variation and population genetic structure of 144 individuals sampled from 12 populations in Taiwan, Kinmen, Hong Kong, and Iriomote-island(Japan). A total of 8 primers were used and 80 polymorphic sites were detected. Among them, 73 bands were polymorphic (91.3%), while 7 bands were monomorphic (8.7%). POPGENE analysis revealed total gene diversity (H) was 0.2982 and genetic differentiation index (Gst) was 0.5464, while gene flow index (Nm) was 0.2076. Analysis of molecular variance (AMOVA) revealed the variance component between population regions was 39.66% ($p < 0.001$), and populations within regions were 19.00% ($p < 0.001$), and among individuals within the population was 41.34 ($p < 0.001$). The result indicated significant genetic differentiation among islands and among populations within islands. UPGMA cluster analysis and principal coordinates analysis (PCoA) showed they were divided into three groups, which were the Taiwan group, the Kinmen and Hong Kong group, and the Iriomote Island group. In addition, a significant correlation was found between genetic distance and geographic distance ($r = 0.63$, $p = 0.01$*). It revealed that populations of *A. marina* agreed to the concept of isolation by distance model, which might be evolved from the result of natural dispersion. In conclusion, the result may have been caused by geographic segmentation and man-made damage, so the gene flow among populations was relatively restricted, and populations on different islands also showed significant genetic differentiation. Based on the above results, both In-Situ and Ex-Situ conservation are necessary in preserving this species.

Key Words: *Avicennia marina*, genetic diversity, gene flow, genetic variation

以臺北植物園為範例評估都市養蜂的效益和可行性

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摘要

近年來，有關都市養蜂的報導與文獻，越來越受到關注與重視。研究指出，蜂類昆蟲除了具備生態上基本的功能之外，也可以衍生出許多與經濟、教育，甚至城市文化與藝術產業相關的其他功能，在都市裡扮演著重要的角色。然而，全球各地都市化的型態與程度不盡相同，從都市道路的規劃到公園綠地景觀設計上的差異，都可能對當地的生態與昆蟲相，特別是對蜂類的生存與繁殖狀態，產生重大的影響。本計畫除了提倡都市蜜蜂的養殖行動之外，藉由都市蜂群的食性，生長週期調查，以及蜂產物產值的計算與養殖成本的評估所獲得的結果，從中彙整出有用的資訊，方便日後作為都市環境改善上，對居家綠化、行道樹和綠地花卉季節性栽植，與植物種類選取等措施，提出有用的建議。

目前，我們先以蜜蜂採集來的花粉與蜂蜜上的殘餘植物 DNA 進行次世代定序，接著將基因序列以 NCBI 上的 Blast 做物種鑑定，之後再與植物園的植物名錄與其物種相應的物候做比對。本計畫以臺北植物園為實驗地點，試圖發展都市養蜂技術，嘗試由前述的實驗分析中，了解都市蜂群是否如預期地採集傳統蜂農所認為的蜜源植物，蜂群對周圍都市潛在蜜源的利用狀態，未來都市景觀的植物配置，城市綠地單位面積上適切的蜂群乘載量，以及相關經濟產品如蜂蜜、蜂蠟、蜂膠等可預期的產能等等議題，進而以此研究基礎所提供的科學數據，作為提高都市養蜂相關之建議在實際執行面的可能性。

有別於商業性養蜂產業大量集中、高人工管理的傳統養殖模式，本計畫以零星分散及低管理密度的方式，在都會綠地推廣蜜蜂養殖，企求營造出友善昆蟲的環境，進一步連結周邊郊山、濕地與淺山生態，在城市裏實踐兼顧社會人文，生產活動和生態保育的里山精神。

關鍵字：城市養蜂、蜜源植物、里山經濟

THE BENEFITS AND EXECUTING POSSIBILITY OF URBAN BEEKEEPING PRACTICE-A PROJECT STUDY AT TAIPEI BOTANICAL GARDEN

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Abstract: In recent years, the reports and research findings on urban beekeeping practice are getting more and more attention. The bee-related studies have shown that in addition to the basic ecological functions, bee insects can also have many other functions that involve with the economy, education, art industries and even the urban culture, playing an important role in the city. However, the patterns and degrees of urbanization vary from place to place around the world, ranging from the planning of urban roads to the design of park green space landscapes, these differences may all contribute great impacts on local ecology and the existing insects, especially on the reproduction and the survival of local bees. Therefore, besides the promotion of urban beekeeping practices, this project also hopes to gather useful information from some targeted studies, such as the feeding habits of honey bee population, population growth and its life cycle, the annual crop yield and its market value of bee products and, the management cost of urban beekeeping practice. More, using these information to improve the future urban environment by offering good advices on the issues of domestic greening projects, seasonal planting plans for street trees and flowers, and the selection of plant species, in the city.

At present, the project would firstly use the pollen collected by the bees and the residual plant DNA in the honey for the Next Generation Sequence (NGS) analysis to identify the plant species. Once the gene sequence is identified by the Basic Local Alignment Search Tool (BLAST) of the National Center of Biotechnology Information (NCBI), the species will be then compared with the plant list of the botanical garden and its corresponding phenology. This project takes the Taipei Botanical Garden as an experimental site, trying to develop urban beekeeping technology. It will then use the findings from the analysis mentioned above to understand: if the urban honey bees would collect the nectar from these source plants traditionally considered by other beekeepers as expected; how the bees would visit other potential honey sources around the city except this garden; the possible planting arrangement in the future urban landscapes for beekeeping in the city; the appropriate hive stocking rates in the urban green space; and the productivity prediction of bee-related products, such as honey, beeswax, propolis, etc. Based on those scientific data, this project might be able to help lift the executing possibility in urban beekeeping practice.

Different from the traditional commercialized beekeeping mode that normally runs a large-scaled and intensively managed business, this project suggests a less intensive and more hive-scattered beekeeping practice in urban green space to create an insect friendly environment. We wish to link the surrounding suburban, wetland and the rural areas, giving the consideration to the cultural and social aspects, production activities and ecological conservation, to realize the concepts of Satoyama in the city.

Key Words: Urban beekeeping, Honey plants, Satoyama economy

桃園埤塘濕地長期候鳥及地景調查（2003-2018）

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摘要

桃園臺地埤塘最盛的時候占桃園臺地面積 11.8%，然而因為土地開發影響，近來埤塘面積僅佔桃園臺地面積 3.8%。都市化導致複雜有機城市結構之橫向發展，並且造成城鄉地域的池景和農地面積的衰減。目前，僅剩下 3800 口埤塘，約占原有埤塘15.4%，84.6%埤塘面積已經消失。桃園臺地因為鄰近臺北都會區，導致埤塘持續減少。然而，因公共埤圳系統使得桃園埤塘開始消失。埤塘充滿了人文歷史，卻因時代轉變與人為活動下迅速消失，埤塘的消失不僅讓我們的文化流失，也破壞了生態系統。桃園埤塘棲地營造出水生與陸生並存之環境，其生態功能主要提供冬季候鳥及留鳥庇護、棲息與覓食之所。埤塘邊岸之微棲地空間，係為鳥類經常出現之區域，如果桃園埤塘消失，將致使大量鳥類的棲地受到壓縮，也會減少冬季候鳥前來桃園渡冬。

本研究自 2003 起至 2018 年止，進行桃園埤塘 44 口之同步調查，每年結合地理資訊系統進行資料鍵入，透過「埤塘零損失」之操作模式，建構埤塘生態服務之功能原則，配合區域地景、歷史及自然保育相關景點，並且劃設埤塘生態保護區及埤塘生態復育區，以利埤塘環境之永續生存。研究地區規劃著重於埤塘區塊、周遭生態節點、廊道及鑲嵌情形，藉由長期性鳥類多樣性調查成果，完成整體桃園埤塘鳥類生態保護區的規劃，以改善埤塘物種豐富度。在分析中探討與歸納相關圖層項目與權重因子，進而研判不同適宜性分析及多目標專家評估準則研商後之潛在適度區位，以及保護、防護和復育埤塘區位，以減少土地開發投資風險，期能讓桃園市埤塘地區獲得更合理之空間規劃與區分利用。本計畫希藉由上述方法，對未來桃園市的環境保護及生態保育，提供管理方針，減少因不當的開發使用所造成之損失。結論建議增進生物多樣性，來探討埤塘生態工程，佐以區域鳥類實證研究及空間分析，提出生態工程景觀設計圖說，達到埤塘自然風貌原味重現的目標。

經費來源：中華民國科技部

關鍵詞：濕地生態、生物多樣性、冬季候鳥

A DYNAMIC INFORMATICS OF PONDSCAPE MATRICES (2003-2018) TO RESERVING FARM PONDS FOR MIGRATORY BIRDS

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Abstract: Man-made farm ponds are unique geographic features of the Taoyuan Tableland. These ponds provide a home for birds and numerous species of aquatic animals in Taiwan. However, urbanization and development of infrastructure resulted in the gradual losses of farm ponds. Currently, only 3800 ponds originally approximately 15.4 % remain, and 84.6 % of the surface area of the ponds has vanished.

Aiming to protect migratory birds, this study enforced from the years of 2003 to 2018 for used spatiotemporal analysis and geostatistical approach to analyze the relationship between bird diversity and landscape structure, in an effort to elucidate the spatial driving force of avian diversity. I detected that regression-kriging (RK) was even more accurate than logistic regression (LR). The results of this study also indicated that an exceedingly strong relationship existed among avian diversity and landscape scale, agricultural landscape indices, and pond landscape indices. The models predict that preservation of large areas of waterscapes and paddy landscapes result in greater diversity of avian species. After studying the results of correlation coefficient associated with validation, it was further confirmed that curvilinear pond shape, sprawling housing, and small pond size have significant influences on avian decline. Spatial estimation of the research area indicated that aforementioned human activity substantially affected avian ecology, leading to reductions in avian diversity. Thus, the reduction of the area of ecological corridors due to urban development is expected to further reduce avian diversity in the Taoyuan region.

Integrated pondscape research must be a long-term project. It is necessary to build a time frame of ten to twenty years. I undertake pondscape-change evaluation that requires the avian data of long-term losses of richness and abundance from year to year. This consideration helps to make the simulation and evaluation model more precise in continuing the work over the long run in wetland ecology. My approach can be used to effectively analyze the correlations between characteristics of ecosystems and the environmental landscape, to ensure that pondscapes can be appropriately maintained and ecological reserves designated to prevent further decline in avian diversity.

Funding source: Ministry of Science and Technology, Republic of China, Taiwan.

Key words: wetland ecology, biodiversity, wintering migratory bird

建立桃園藻礁中工業汙染影響較小區域內殼狀珊瑚藻群落結構之生態基礎線資料

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摘要

桃園藻礁是以殼狀珊瑚藻為主要建礁生物所形成的礁體,也是目前已知的現生藻礁生態系規模最龐大的海岸線，含蓋桃園市大園區、觀音區及新屋區一帶的海岸線約 27 公里，北邊因工業高重金屬酸性廢水汙染而受到嚴重的破壞，目前僅存南邊白玉至觀新約 9 公里較為健康的藻礁生態系。然而，臺灣政府預計在白玉與觀新中間的大潭藻礁區域新建天然氣接受站(約 3 公里長)，進一步威脅桃園藻礁生態系。在過去研究，雖有殼狀珊瑚藻多樣性定性資料研究，但各藻種相對豐富度定量資料則尚未加以調查,使得藻礁生態系保育相關議題缺少科學數據的論證。故本計畫預計在白玉藻礁、大潭藻礁（G1 和 G2）及觀新藻礁（永興及永安）約 7 公里的藻礁區域，在殼狀珊瑚藻生長最佳的春季（四月），針對各地點潮間帶低潮位區域，使用葉綠體 psbA DNA 生命條碼，系統性隨機調查 50 個樣本，以了解各地區殼狀珊瑚藻多樣性及不同藻種相對豐富度異同，相關數據將使我們更了解桃園白玉至觀新不同區域藻礁殼狀珊瑚藻藻種多樣性及其群聚結構組成異同。扎實生態科學數據，將有助於政府與民眾了解與重視藻礁生態保育，並有助於後續藻礁保育之規劃。

經費來源：行政院農委會，臺灣。

ECOLOGICAL BASELINE ASSESSEMENTS ON CRUSTOSE CORALLINE ALGAE ASSEMBLY IN A LESS INDUSTRIALLY POLLUTED AREA OF TAOYUAN ALGAL REEF, TAIWAN

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Abstract: Over the past few decades, the 27 km Taoyuan Algal Reef (TAR) built by crustose coralline algae has suffered a long-lasting heavy metal-rich and highly acidic pollutions from nearby industries at its northern part. These pollutants challenged the growth of crustose coralline algae and subsequent reefal build-up potential in this area, resulting in the southern part of TAR as a less industrially impacted area (ca. 9 km). However, the Taiwan government recently plans to develop a Liquefied Natural Gas harbor (ca. 3 km in length) in the southern part of TAR, thereby rising another major threat to the TAR conservation. Unluckily, the ignorant or insufficient ecological assessement on the crustose coralline algae at TAR hampered further conservation acts to preserve this uncommon algal reef ecosystem in Taiwan. To this end, this study is set up to assess ecological baseline on the crustose coralline algae assembly primarily in the southern part of TAR. Barcoding plastid *psbA* DNA from 50 random samples at each site, we retrieve species diversity and relative abundance of crustose coralline algae from the low-tide region of 5 different sites in the southern part of TAR during the Spring season in 2018. The outcome of these data can provide further insights into the TAR conservation act.

Funding source: Council of Agriculture, Executive Yuan, Taiwan.

龍鑾潭水質與水生生物長期監測資料之歷年變化

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摘要

龍鑾潭位於屏東縣恆春鎮，為墾丁國家公園內最大的淡水水域，也是重要的冬候鳥棲息地。本研究匯整 2011 年至 2018 年水質與水生生物的資料。經統計分析結果顯示，龍鑾潭水質均屬未(稍)受污染至輕度污染的等級，但是有優養的狀態，其南側樣點水中的有機物質與含氮營養鹽有偏高的狀態。利用主成份分析(principal component analysis, PCA)分析所有的水質參數。其結果顯示，造成龍鑾潭水質變化最主要的水質主要因子為水中的有機物質及含氮營養鹽(硝酸鹽及亞硝酸鹽)；同時，落山風季及棲地型態為重要的外在影響因子。歷年龍鑾潭魚類及底棲生物魚類統計，此處共有 7 科 21 種魚類，數量以餐條最多，但是近年有減少的趨勢,其中來外來種魚類則有增加的狀態;底棲生物共調查到 21 科 75 種，數量以石田螺最多，歷年亦呈現減少的狀態。經由歷年龍鑾潭魚類及底棲生物與鷺鷥及水鴨數量分析結果顯示，鷺鷥及水鴨的數量均與魚類的數量呈現反比，水鴨的數量與底棲生物的數量亦呈現反比的狀態。由此推測，龍鑾潭為冬候鳥到此補充食物的休憩場所。龍鑾潭目前環境穩定，主要污染來源為南側注入水，需注意人為放生以及管制外來魚種造成的後續問題。

關鍵字：墾丁國家公園、龍鑾潭、水質、水生生物

LONG-TERM MONITORING OF WATER PARAMETERS AND AQUATIC ORGANISMS IN LUNGLUANTAN

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Abstract: The Lungluantan is the largest fresh water lake in Kenting National Park. This research collected and analyzed data including water parameters, benthic invertebrates (shrimps, crabs and mollusks) and fishes during 2011 and 2018 in Lungluantan. The scores of RPI and CTSI showed the water quality in the Longlung Lake varied from good to moderately polluted and eutrophic status, respectively. The dataset was treated using Principal Component Analysis (PCA) to extract the parameters that are most important in assessing variation in water quality. Two Principal Factor were identified as responsible for the data structure explaining 90% of the total variance of the dataset, in which organic material (51.0%), nutrient factor (10.0%, such as NO_3^- and NO_2^-) that represents total variance of water quality in the Lungluantan. And the other way, the seasonal wind and type of habitat are important effect about water quality. The dataset showed 75 species of benthic invertebrates and 21 species of fishes were collected from the Lungluantan. The number of herons and water ducks, winter migratory birds, are inversely proportional to the number of benthic invertebrates and fishes. It is speculated that Lungluantan is a resting place for winter migratory birds to supplement food. Although the water quality and aquatic communities maintained steady, the illegal fishing, invasive fishes, and wastewater emission required continuous attention for the Longlung Lake

***Key Words*:** Kenting National Park, Lungluantan, water quality, aquatic organisms

變化聲景在低能見度的溼地魚類生態長期監測應用 -桃園藻礁為例

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摘要

珊瑚礁或是其他生物礁的長期監測多用水下目視調查(underwater visual census)配合穿越線、相機或是攝影機來紀錄礁區生物的種類和豐度。然而，許多原本地理環境就有很多陸源懸浮物或是受到人為影響的低能見度近海礁區，常常無法有效的利用上述方法來進行調查，像是紅樹林、河口、溼地及藻礁等。這些地區過去常用網具等陷阱方式捕捉海洋生物，作為定量或是監測的紀錄方式。然而，不同地區的網具種類及設定不同，抑或是網具或是陷阱具有很大物種選擇性，造成這些地區的長期監測有很大的困難。近年來，水中錄音設備及分析技術的改進，水下聲景技術開始慢慢用在研究與長期監測的方式。不過，這些水下聲景與其他採樣方式的成果比較仍不多，因此本研究利用水下錄音設備與資料分析，和其他網具採集方式的魚類資料對於桃園藻礁受到人為干擾的程度進行比較。目前初步結果顯示靠近工業區的藻礁在魚類多樣性和水下聲景多樣性都比觀音保護區和大潭藻礁來得低。雖然目前聲景多樣性資料與魚類採集結果一致，但是更詳細的長期監測還需要時間的累積。

關鍵詞：大潭藻礁、人為干擾、工業污染

THE APPLICATION OF SOUNDSCAPE IN LONG-TERM ECOLOGICAL MONITORING OF LOW VISIBILITY WETLAND - TAOYUAN ALGAL REEF

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Abstract: In coral reefs or other bioherm, using underwater visual census (UVC) with transect or other photography and videography is the most common method to monitor biodiversity in these reefs. However, many other reefs or ecosystems, such as mangrove, estuary, wetland or algal reefs, which are vulnerable by land-source sedimentation or human disturbance are difficult to survey quantitatively with above methods. Surveys in these habitats highly depend on nets and traps to catch marine creatures and these methods are all species-dependenent sampling. Recently, more and more studies using soundscape method to study and monitoring underwater environments. However, using both traditional sampling method compared with soundscape recording is still limited in underwater environments. Here, we use both soundscape recording method along with traditional netting and anesthesia to record and compare the fish diversity and abundance in algal reefs where is normally low visibility and high wave energy shallow water ecosystem. For preliminary data, the finding from soundscape and netting method is similar. A much long term monitoring cross seasons is necessary to fully understand the differences between soundscape and traditional method.

Keywords: Datan algal reefs, human disturbance, industrial pollution

溼地復育與溼地構築：一些美國的例子

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濕地包括三個主要的組成部分：(1) 地表水（通常淺水）或水在根層，呈現飽和狀態，(2) 水成土壤，通常含有分解中的植物碎屑物，以及 (3) 水生植物。1970 年代之前，濕地排水和填土用於農業和城市發展是當時所被接受的公共政策，甚至受到政府計劃的鼓勵，有些國家竟因這些原因而使 90%的濕地遭受損失。緊接著在 20 世紀 70 年代爆發了有關對濕地保護的浪潮。1971 年特別針對水鳥棲地保護設立了國際重要濕地公約（拉姆薩爾公約），此公約是一項國際條約為世界各地的濕地保育提供基礎，共有 150 多個國家參與該協議。自 1970 年代以來，濕地保護已經演變並發展出涵蓋溼地復育與濕地構築，溼地復育即修復已存在但退化中的濕地，溼地構築就是創造新的濕地。本研究討論了美國東部濕地復育和濕地構築的例子，包括選址，方法，成本，以及私部門參與的機會。

關鍵詞: 溼地復育、溼地構築、溼地保育

WETLAND RESTORATION AND CREATION: SOME AMERICAN EXAMPLES

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Abstract: A wetland includes three major components: (1) water at the surface (usually shallow) or in the root zone (usually saturated); (2) hydric soils with decomposing plant material; and (3) hydrophytic vegetation. Before the 1970s, wetland drainage and filling for agricultural and urban development were generally accepted and even encouraged by government programs. Some countries have reported 90% wetland losses. Interest in wetland conservation exploded in the 1970s. The Convention on Wetlands (Ramsar Convention) of 1971 is an international treaty that provides a basis for wetland conservation of around the world, with over 150 countries participating in the agreement. Since the 1970s, "wetland conservation" has evolved to include "wetland restoration," rehabilitation of preexisting but degraded wetlands, and "wetland construction", creating new wetlands. This study discusses examples of wetland restoration and construction in the eastern United States, including site selection, techniques, costs, and opportunities for private sector participation.

Keywords: Wetland restoration, Wetland construction, Wetland conservation

溼地景觀設計與願付價格關係之研究—
以台中高美濕地為例

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摘要

台中高美溼地為現行濕地保育法規範下的國家級濕地，高美溼地本身形成原因特殊，由日治時期經營的海水浴場，至現今台中港發展而淤積荒廢後所形成的自然濕地環境。由於濕地具備自然景致、傳統漁業與豐富的生態資源等條件，在現今仍造就了可觀的觀光人數。因此，在觀光產業盛行與生態復育交互並存的時空背景下，高美濕地為相當適合探討自然溼地明智利用的基地。本研究有別於單純探討濕地條件評價法之研究，而是以景觀設計項目為自變數，民眾對於濕地願付價格為依變數，主要探討溼地景觀設計完成前後，與遊客、居民及商家的願付價格之關係。研究方法以簡單線性迴歸分析及條件評價法（CVM）進行分析，由上述方法可得景觀設計與保育濕地之願付價格之間的相關係數，並以此進一步分析高美濕地景觀設計中的木棧道、沿岸步道、休憩設施、公共藝術、導覽告示牌及景觀橋等設計項目與願付金額之個別相關性，最後總體分析溼地景觀設計影響濕地願付價格之差異程度。本研究核心價值在於探討景觀設計對於濕地之社會效益面，當前關於濕地景觀設計的研究著重於人工溼地的應用與效益分析，鮮少探討對自然溼地與景觀設計的關係，為達到實質的生態保育與明智利用，應當重視民眾對於回饋濕地意願的影響因子進行討論，方能更深入地落實濕地公私合力下的實質永續經營。

關鍵詞：溼地景觀設計、條件評價法、願付價格

THE RESEARCH ABOUT LANDSCAPE ARCHITECTURE AND WILLINGNESS TO PAY IN THE WETLAND：THE CASE STUDY OF TAICHUNG KAOMEI WETLAND

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Abstract: Taichung Kaomei is the national-level wetland, which is regulated ecology conservation and wise utilization by current Wetland Conservation Act. Kaomei Wetland is the form of an unusual course, and it's the popular beach during Japanese. Until Taichung Port gradually develops over, the beach is silted up increasing and even deserted. After a while, the uncultivated land becomes the natural wetland. Although Kaomei Wetland is no longer the famous beach, it depends on the unique views that are combined with sunset, traditional fishery, and rich ecology resource. Also, to be the international-level tourism attraction. Therefore, Kaomei Wetland may be the most suitable case for representing wise utilization in the wetland by its condition. The research is different from another research study in wetlands with contingent valuation method（CVM）. As a matter of fact, the research focuses on the willingness to pay（WTP） that mutual influences of the landscape architecture and visitors, residents and merchants. In this study, the simple linear regression models method and CVM is used. The correlation coefficient between landscape architecture and WTP may promote to analyze each relation in wooden walkways, coastal walkways, recreational facilities, public arts, interpretative signs, and the landscape bridge. Finally, explore the influences of landscape architecture and WPT. Actually, to penetrate deeply into how many effects of the landscape architecture of social is the core of the research. There are a lot of papers discussing the applications in constructed wetlands. Instead, the little research discusses effects on landscape architecture in natural wetlands. To implement wetland ecology conservation and wise utilization, it must both attach the willingness for public participation. It may be more capable of achieving the sustainable operation of the wetland in the public-private partnership.

Key Words: landscape architecture, contingent valuation method, willingness to pay

濕地法的政策執行困境

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摘要

濕地保育法於 2015 年 2 月 2 日實施，主管機關是內政部營建署城鄉發展分署。等於說濕地保育有了法律或正式規範,可以讓台灣現有濕地獲得應有的保護。也可以說濕地保育法的施行，等於讓濕地保育政策形成跨出了一大步。然而，濕地法或濕地保育政策執行過程，卻出現困境。在台南甚至引發軒然大波，遭地方政府（特別是區公所）以及漁塭養殖業者的抗議與反彈。甚至高雄茄萣濕地，雖為黑面琵鷺重要棲息地；卻因開發利益，從國家級降為地方級濕地。這些案例都凸顯濕地保育政策存在執行困境。本論文的目的，即針對濕地保育政策執行的困境進行研究，探討濕地保育政策執行困境的成因。為探討這議題，首先必須釐清濕地保育政策執行困境的內涵，再從政策執行困境探索政策執行困境的成因。作者採用多年來發展的理論型模進行研究，從資訊、動員、組織間合作等三個自變項，探討依變項的政策成效（困境）。

關鍵詞：濕地法、政策執行、資訊、動員、組織間合作

URBAN WETLAND: TRANSFORMER OF LAND VALUE SYSTEM

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Abstract: The Wetland Law of Taiwan has been passed and has been implemented on February 2nd of 2015. The mission was assigned to Urban and Rural Development Branch, Construction and Planning Agency, Ministry of the Interior. It was expected that wetland conservation could be formally protected by law in Taiwan. The pass of Wetland Law of Taiwan implied important movements of wetland conservation policy formation. However, there has been difficulties of implementing the Wetland Law. For example, it was reported that a lot of fish pond farmers together with local officials were publicly against the Wetland Law in Tainan City. It was argued that the farmers and local officials were not informed when formulating the wetland policy. In addition, the Jiading Wetland in Kaohsiung City, an important habitat for Black Face Spoonbill Bird, was downgraded from national to local level in order to have economic development. It meant that there are difficulties and paradox for wetland conservation policy. Therefore, the purpose of this paper is to explore the causes and difficulties of wetland conservation policy. The difficulties and paradoxes have to be identified. Then the causes of difficulties could be explored. A conceptual framework developed by the author was adopted to study this issue. The independent variables were information, mobilization, and inter-organizational collaboration. The dependent variable is policy effectiveness or difficulties.

Key Words: The Wetland Law, Policy Implementation, Information, Mobilization, and inter-organizational collaboration

以科學為基礎，強化金門慈湖濕地的生態功能與明智利用

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金門地區之生物資源豐沛，慈湖為生物棲息之重要濕地。然而，過去研究多著重於鳥類、水獺或植物等自然資源調查，較少以生態系觀點針對水域棲地及水生生物做統合性分析，更遑論周邊人類利用方式與濕地關聯性之探討。因此，為瞭解影響慈湖濕地生態系之重要因子，本計畫以生態系角度探討各濕地之棲地環境現況。除了生物與環境之相互關係外，更融入周遭土地利用現況及人為活動調查，以探討人類影響這些濕地生態系之生物多樣性與功能，藉由改善不當之利用行為，達成濕地生態系之明智利用與永續。本計畫於 2016 至 2018 年，執行慈湖之水質、水文、基礎生產者、水生生物、鳥類、土地利用等調查工作，並建構生態系食物網模式，以提出完整之經營管理方案。慈湖東側因農業污水、畜牧污水與家庭污水注入導致水質不佳，加上底質缺氧且泥濘，極不利於二枚貝類生長；但因溝渠之有機碎屑輸入，聚集許多小型魚類與蟹類，為鳥類之重要食物資源。反之，慈湖西側受溝渠淡水影響較小，且水體流動程度佳，故水質狀態相對優良；此區之螺貝類種類豐富，其中亦包含慈湖之經濟性物種菲律賓簾蛤。為改善慈湖水體交換，金門國家管理處於 2017 年起增加防潮閘門開啟率，結果顯示，此操作不僅改善慈湖西側水質，亦改變慈湖中部底質狀態與螺貝類組成。菲律賓簾蛤多分布於底質含砂量較高之測站，但在夏秋季疑因漁民採捕與鹽度過低等因素，致使族群量極低，但今族群量有回升之趨勢。本計畫研究結果建議，菲律賓簾蛤適宜之採捕殼長需大於 31.1 mm，避免於繁殖期(9-11 月)採捕。慈湖食物網模式指出，慈湖之蝦蟹類、螺貝類、多毛類等底棲生物十分豐富，卻缺乏上層掠食者，使系統整體之傳輸效率僅有 1.42%，生態功能不彰。關鍵指數分析顯示，水獺與肉食性鳥類對各生物類群之影響力甚強，為慈湖之關鍵物種，為保育標的。

SCIENCE-BASED ENHANCEMENT OF ECOLOGICAL FUNCTION AND WISE USE IN THE CI LAKE WETLAND OF NATIONAL IMPORTANCE

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Ci Lake is an important habitat for many organisms. There were some prior researches quantifying biological resources such as plants, birds and otters in Kinmen, but much less focusing on the relationships between wetlands and human impacts. In recent years, the water quality reports revealed that nutrient and sediment input are causing habitat degradation at Ci Lake. In order to clarify the source of pollution, water quality, hydrological parameters and land use in Ci Lake were determined every three months during 2016-2018. Besides, survey of plants, birds, fish, benthic invertebrates, and ecosystem metabolism were conducted to examine the structure and functioning of these ecosystems. Water quality in Ci Lake became worse due to agriculture, husbandry and domestic sewage, especially at the eastern side. These polluted water also led to sediment deposition, and resulted in lower mollusk's diversity. However, crabs and small fish were attracted by the rich organic matter, and then were the food resources for birds. In contrast, better water quality and sandy substrate at the western side led to more species richness of mollusks, including Ruditapes philippinarum. Kinmen National Park Headquarters started to adjust the floodgate to improve the water exchange in Ci Lake since 2017. As a result, the water quality in the western side of Ci Lake has been improved, and the sediment condition and diversity of Mollusks in the middle of Ci Lake have been improved. Most of R. philippinarum were found at sites C1, C2, and C3 with sandy sediments. However, the population of R. philippinarum was quite low in summer and autumn, possibly due to agricultural pollution and low sanility. At present, the population of R. philippinarum at sites C1 and C3 are increasing. Results of this project show that the suitable catchable size of R. philippinarum is 31.1 mm of shell length, and no catch period for the reproductive period during September to November. The food web model of Ci Lake shows that shrimps, crabs, mollusks, polychates were abundant here. But few predators led to the low transfer efficiency (1.42 %). Keystoneness shows that otters and carnivorous birds were the keystone species and deserve conservation in the trophic web of Ci Lake.

武陵七家灣溪拆壩後之長期生態效益

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摘要

拆壩能直接且有效解決溪流棲地破碎化所造成的問題。而七家灣溪的防砂壩造成臺灣櫻花鉤吻鮭(Oncorhynchus masou formosanus)保育的難題，有鑑於此，15 公尺高的七家灣溪一號防砂壩部分移除工程於 2011 年 5 月底進行。本研究目的在於瞭解拆壩後溪流食物網結構以及生態功能的長期影響。首先，我們透過拆壩事件對於溪流生物的效應與來自然洪水事件對於溪流生物的效應進行比較；同時，研究利用 BACI (before-after-control-impact)實驗設計，在四個研究測站，以及時間在 2010~2013 年進行調查，並量化溪流生態系中環境因子與生物群集的資料。統計結果(ANOVA, PERMANOVAs 以及 db-RDA)皆顯示，拆壩時間點選在洪水季節前，溪流生物群集與環境因子對拆壩事件與洪水事件有相類似反應。再者，本研究進一步建構壩上、壩下以及拆壩前、後，分別四個食物網模式；探討拆壩後，壩下測站食物網以及壩上測站在新調查記錄物種臺灣鏟頷魚(Onychostoma barbatulum)進入系統後食物網生態功能之改變。研究利用 Ecopath with Ecosim 軟體分別建立拆壩前 2009 年以及拆壩後 2013 年食物網模式。結果顯示，無論是壩上或是壩下測站，拆壩後食物網模式皆有輕微劣化的趨勢，顯示拆壩對於壩下測站的影響小於整體流域的影響；此外，臺灣鏟頷魚作為系統中級消費者，能減少河烏對於小鮭魚的捕食壓力。綜合以上，不論是生物群集或是食物網生態功能對於拆壩的反應皆顯示，當要移除人造阻攔物時，工程時間點的選擇可以減輕工程過程對於系統的影響。

關鍵字：臺灣櫻花鉤吻鮭、臺灣鏟頷魚、拆壩、before-after-control-impact、Ecopath with Ecosim

LONG-TERM ECOLOGICAL EFFECTS OF DAM REMOVAL IN SUBTROPICAL MOUNTAINOUS STREAM

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Abstract: Dam removal has the potential to efficiently solve the problems caused by fragmented stream habitats but may simultaneously cause negative impacts on biotic communities. To conserve the critically endangered Formosan landlocked salmon (Oncorhynchus masou formosanus), a 15-m-tall check dam was partially removed from the Chichiawan Stream at the end of May 2011, before the flood season. We aimed to determine impacts of dam removal on the structure and functioning of stream ecosystems. We cast dam removal as an action comparable to a natural flood event. We applied a before-after-control-impact (BACI) design and quantified the environmental factors and major biotic communities at four sampling sites from 2010 to 2013. All the results of ANOVA, PERMANOVAs and db-RDA demonstrated that stream communities responded to dam removal as a natural flow alteration because the timing of the dam removal occurred just before the flood season. We further constructed the trophic model using Ecopath with Ecosim after dam removal, which allowed us to compare the functioning before (2009) and after (2013) dam removal. It is noted that Taiwan shoveljaw carp (Onychostoma barbatulum) had no records before dam removal in the upstream. The results showed that the functioning of food web were slightly degraded at both sites above and below the dam before and after dam removal due to more floods. This demonstrated that the effects of fluviation were greater than the impacts of dam removal at the site below the dam. In addition, the Taiwan shoveljaw carp was found to decrease the predation pressure of Brown Dipper (Cinclus pallasii) on the juvenile salmon. In conclusion, both responses of stream communities and functioning of food web to dam removal demonstrated that appropriate timing to remove dam could mitigate ecological impact on stream ecosystems.

Key Words: Oncorhynchus masou formosanus、Onychostoma barbatulum、dam removal、before-after-control-impact、Ecopath with Ecosim

整合生態調查與問卷進行野生動物保護區的分區劃界規劃：以台灣鰲鼓溼地為例

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摘要

海岸濕地具有高生物多樣性與高生產力的特點。台灣係一個海洋國家，因此台灣沿岸具有諸多海岸濕地。其中西南沿海的鰲鼓濕地是國際知名的海岸濕地，亦被公認為亞洲主要濕地之一。目前嘉義縣政府正積極考慮將其更進一步的將其提昇為野生動物保護區，使其受到更完善的保護。本文研究目的旨在建立一套客觀的程序與科科學方法，以協助野生動物保護區的劃界和與分區規劃。首先本研究透過向權利關係人提供鰲鼓的棲地條件與生物多樣性指標訊息，作為問卷調查時的參考依據，問卷回收後透過統計分析的方法整合受訪者的建議。保護區能否成立該環境區域內是否有其重要的保護標至關重要，據過往研究調查鰲鼓濕地野生動物棲息環境中的最主要生物是多樣化的水鳥。因此在本研究中我們首先透過中華野鳥協會取得鰲鼓棲地內所觀察到的歷年所觀察到的鳥類物種與數量統計資料；並透過家嘉義縣政府取得該區域內的地景分布情況與其他資源生物資源的分布狀況。以鳥類多樣性作為鰲鼓溼地的重要保護標的，亦符合目前「野生動物保護法」劃設重要棲息環境或野生動物保護區的要求。在問卷設計之前我們選用常見的四種生物多樣性指標來表示每個監測點的鳥類物種多樣性與豐富度指標。此外，為了找到鳥類物種多樣性的空間分佈情形，本研究採用普通克里金法進行空間數值內插，以彌補測點數不足的狀況。問卷要求權利關係人(或受訪者)在問卷中以圖示的方式標定野生動物保護區中的核心區，緩衝區與可持續利用區範圍，本問卷的優點在於提供以往質性問卷難以定量的缺點，據此整合權利關係人所考量的因素。雖本研究僅以鰲鼓濕地為案例，然基於公眾或權利相關者意見的收集與參與進行保護區規劃的方式乃目前世界潮流與趨勢，亦是保護區設立後能否永續經營的重要關鍵因素，故本研究所提出的方法亦可廣泛適用於任何形式的保護區的規劃與設計。

關鍵字：分區規劃、生物多樣性指標、問卷、野生動物保護區、濕地

INTEGRATION OF ECOLOGICAL SURVEYS AND QUESTIONNAIRES TO DETERMINE DELIMITATION AND ZONING OF WILDLIFE RESERVE：A CASE STUDY OF AOGU WETLAND IN TAIWAN

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Abstract: Wetlands in coastal area have the features of high biodiversity and biological productivity. Taiwan is a maritime country, so there are many coastal wetlands. The Aogu Wetland in southwestern Taiwan is an internationally renowned coastal wetland which has been recognized as one of the major wetlands in Asia by the Wetlands International. The Taiwanese government is now considering establishing a wildlife reserve in Aogu Wetland. The purpose of this study is to develop an objective and science-based procedure to assist the delimitation and zoning of wildlife reserve. It can provide stakeholders with information on habitat conditions and biodiversity indicators as a reference for the questionnaire survey and then integrate interviewees' suggestions through statistical analysis.The main wildlife to be conserved in the wildlife reserve of Aogu wetland are the diversified waterfowls and birds. Therefore, in this study, we first need to collect and analyze the bird habitat conditions in the proposed area and the number of birds observed at the monitoring sites. According to the Wildlife Conservation Law, bird species diversity is selected as the conservation target of wildlife reserve. We use four biodiversity formulas to represent the bird species diversity index for each monitoring site. Further, in order to find the spatial distribution of bird species diversity, we used the ordinary Kriging method to do spatial interpolation to make up for the shortage of measuring points and to extend the information of points to the spatial distribution of bird species diversity. Information mentioned above was provided for questionnaires to ask stakeholders to delimit the Central Zones, Buffer Zones and Sustainable Utilization Zones of the wildlife reserve. A quantitative method for zoning of protected areas was then developed to integrate stakeholder considerations.Although this is a case study on Aogu Wetland, nevertheless, the proposed delimitation and zoning method, based on combining public opinion, could be applied to any other protected areas.

Key Words: zoning, delimitation, biodiversity indicators, questionnaire, wildlife reserve, wetland

史無前例的桃園藻礁：已知、未知、無法知

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摘要

桃園藻礁位於台灣的西北海岸，是由殼狀珊瑚藻與造礁珊瑚經過 7500 年的群聚消長建構而成。在約 4400 年前造礁珊瑚消失之後，殼狀珊瑚藻成為桃園藻礁主要的建構至今，使得桃園沿岸沙灘潮間帶至潮下帶上緣由殼狀珊瑚藻緩慢堆疊而成藻礁成為史無前例的特殊生物礁生態系。但由於過去棲地破壞的工業污染已使得原本綿延 27 公里的桃園藻礁只剩約南桃園大約 5 公里從白玉至永安段的海岸仍維持相對完整的藻礁生態系。2014 年在初步評估南桃園藻礁生物多性與生態之後，桃園市將新屋溪口至永安劃設觀新野生動物保護區。但是，對於北段的白玉與大潭段藻礁的相關資料闕如。

本論文藉由組成跨領域研究團隊針對南桃園藻礁生態、生物多樣性與社經狀態，特別是大潭段的藻礁礁體，進行研究，並整理過去對於桃園藻礁研究文獻，就桃園藻礁已知、未知以及無法知的科學資訊進行整合，期以提出桃園大潭藻礁相關的保育措施。

關鍵詞：桃園藻礁、大潭藻礁、史無前例生態系、保育（5 個以內）

UNPRECEDENTED TAOYUAN ALGAL REEFS: KNOWN, UNKOWN, AND UNABLE TO KNOW

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Abstract: Taoyuan algal reef, located at the northwestern coast of Taiwan, is a biotic reef built mainly by the interaction between crustose coralline algae (CCA) and scleractinian corals since 7500 years ago. Taoyuan algal reef is an unprecedented biotic reef system because CCA becomes the dominant reef builder after corals stop to grow along the coast of Taoyuan. Nevertheless, over 75% of Taoyuan algal reef along the 27-km coast are disappeared due to coastal development and industrial pollution in the last 40 years, the 5-km of southern section of Taoyuan algal reef, ranging from Bai-Yu to Yuan-An, remains relatively healthy. The section between Xin-Wu estuary and Yuan-An was established as Guan-Xin wildlife protected area in 2014 after the preliminary assessment of biodiversity and ecological status. The biological and ecological data of the northern section between Bai-Yu and Datan remains to be studied. In this study, a multidisciplinary approach, including biodiversity and social ecology was taken to examine the status of algal reef in the southern Taoyuan, particularly the section between Bai-Yu and Datan. Scientific information of those known, unknown, and unable to know regarding to unprecedented algal reef ecosystem are compiled and potential conservation strategies are proposed.

Key Words: Taoyuan algal reef, Datan algal reef, unprecedented ecosystem, conservation

江門新會小鳥天堂國家濕地公園健康評價研究

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摘要

濕地作為地球三大生態系統之一，具有重要的生態、經濟和社會效益。濕地公園健康是濕地公園服務功能得以發揮的保證以及可持續發展的重要前提，對其開展健康評價研究，可推動濕地公園向更好更健康的方向發展。

濕地公園的定位決定了濕地生境的保護與營建、人類行為的引入與干擾將長期並存於濕地公園當中，而我國目前有關濕地公園建設的規範與標準中，未有基於人與濕地互動模式下的濕地生境健康評價指引。目前國內對於濕地公園健康評價的方法和模型大多數是源於濕地生態系統評價的直接運用或借鑒，專門針對濕地公園的評價模型尚未成熟。

本文以江門新會小鳥天堂國家濕地公園為研究物件，在總結現有濕地公園健康評價研究的基礎上，選用綜合指數法和結構功能指示法結合的方式搭建濕地公園健康評價模型框架，針對小鳥天堂內的濕地公園功能佈局、濕地公園生境營造和濕地人工資源及管理的特點，採用“結構—功能”的分級標準選取 38 個評價指標，對其包含的所有結構要素和涉及功能進行健康評價，並運用層次分析法對小鳥天堂濕地公園的健康情況作出定量的分析。

研究主要結論有以下兩方面：

（1） 本文建立的健康評價模型以“結構—功能”為標準共分為三級，包含了組成濕地的基本元素：水、土、植物、動物；公園整體特徵：斑塊、廊道；以及各種服務功能。對於濕地公園的健康評價，應結合生態以及遊憩等多種理論，其涉及方面應該盡可能地涵蓋濕地公園的所有元素以及濕地公園的全部功能。

（2） 小鳥天堂國家濕地公園的健康評價得分為 2.84 分，目前處於亞健康狀態；雖然結構要素的相關指標較符合健康標準，但功能要素上沒有得到很好的發揮。據此從功能佈局、生境營造和人工資源及管理三個方面對小鳥天堂提出設計優化建議。

關鍵字：濕地公園；健康評價；可持續發展；小鳥天堂國家濕地公園；水鳥棲息地

THE HEALTHY EVALUATION OF THE BIRDS PARADISE NATIONAL WETLAND PARK IN XINHUI, JIANGMEN

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Abstract: As one of the three major ecosystems of the earth, wetland has important ecological, economic and social benefits. The health of Wetland parks is an important prerequisite to ensure the function and sustainability of the Wetland parks. The research on health evaluation for wetland parks could help them develop better and healthier..

The characteristic of the wetland park determines that not only the protection and construction of the wetland habitat, but also the introduction and interference of human behavior will coexist in the wetland park for a long time. However, in China, the current regulations and standards for wetland park construction are lack of guidelines for wetland habitat health assessment based on the interaction model between humans and wetlands. What is more, most of the methods and models for the evaluation of wetland parks in China are directly derived from or used for the evaluation of wetland ecosystems. The establishment of the evaluation model for wetland parks is still in the process of exploration.

This paper takes The Bird Paradise National Wetland Park in Xinhui district, Jiangmen, Guangdong province as the research object. Based on the summarization of the literature on wetland park health evaluation research, this paper put forward a wetland park health assessment model framework through combining the comprehensive index method and structural function indication method. According to the layout of the wetland park in the Bird's Paradise, the habitat construction of this Wetland Park, the artificial resources and management of the wetland, this paper selected 38 evaluation indicators on the basis of the “structure-function” grading standard. Then we conducted a health assessment of all the structural elements and related functions. Furthermore, the analytic hierarchy process （AHP） are used for quantitative analysis of the Bird's Paradise Wetland Park. The main conclusions of the study are as follows:

(1)In this paper, the established health evaluation model is consists of three levels based on the “structure-function” standard. It includes the basic elements that make up the wetland, the overall characteristics of the park and various service functions. The health evaluation of Wetland Park should be combined with theoretical of ecology, recreation and other fields, and should cover all the elements and functions of the wetland park as much as possible.

(2)The result of the health evaluation for the Birds Paradise National Wetland Park is 2.84 points, which means the health of this Wetland Park is currently in a sub-health state. Although the relevant indicators of structural elements are accorded with health standards, the functional elements are not worked well. According to the evaluation results, this paper bring forward some design proposals for the Bird Paradise to develop better from three aspects such as the functional layout, habitat construction and park management..

Key Words: Wetland Park, Health Evaluation, Sustainable Development, The Bird Paradise National Wetland Park; Waterfowl Habitat

黑面琵鷺保育及四草濕地生態系統服務之價值評估

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摘要

千禧年生態系統評估(2005)指出海岸濕地提供許多生態系統服務，Costanza et al. (1997)估計全球海岸濕地生態系統服務價值約每年 12.56 兆美元。台南四草濕地屬於國際級濕地與重要野鳥棲息地，當地鳥類以 IUCN 紅皮書瀕危等級的黑面琵鷺最為著名，每年約 45%黑面琵鷺在冬季遷移至此渡冬，故成為黑面琵鷺之全球最大渡冬地區。自 2016 年始執政的政府採取非核家園政策，規劃以太陽光電與離岸風力替代核能，因此沿海地區成為離岸風機設立首要場域，但是許多民眾與環保團體憂心風機設立會對沿海濕地生態系產生負面影響，進而降低濕地生態系統服務的價值。本研究以條件評估法（CVM）衡量全國民眾對四草濕地生態系統服務的總合願付價值，同時透過選擇實驗法評估民眾對四草濕地之七種屬性的效用偏好，而後再依據屬性效用偏好推估值為權重拆解黑面琵鷺價值。研究結果顯示：民眾每年對四草濕地所提供生態價值的願付金額為 89.83 億元；在四草濕地七種屬性中，民眾重視屬性依序為一般鳥類、稀有鳥類與黑面琵鷺，其他屬性如濕地活動、濕地面積、濕地地貌及濕地產業之效用偏好較低，效用值反應民眾重視濕地生物多樣性，依據權重拆解推估民眾每年對黑面琵鷺保育的願付金額為 15.87 億元。本研究所估算之四草濕地價值，可提供政府與社會大眾於濕地進行各種開發計畫時，權衡濕地開發效益與保育價值，亦可作為濕地損害之求償依據。

關鍵詞：四草濕地、黑面琵鷺、生態系統服務、條件評估法、選擇實驗法

VALUATION OF BLACK-FACED SPOONBILLS CONSERVATION AND ECOSYSTEM SERVICES OF THE SIHCAO WETLAND IN TAIWAN

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Abstract: The Millennium Ecosystem Assessment indicates coastal wetlands provide lots of ecosystem services, that worth 2.56 trillion annually in the globe (Costanza, et al., 1997). The Sihcao Wetland located in Taiwan southwest coast is an Important Bird Areas (IBAs) and a main habitat in winter for Black-faced Spoonbills, a bird ranked as Endangered (EN) in IUCN Red List. In order to achieve the goal of the nuclear-free homeland, the Taiwan government plans to install offshore wind turbines and solar PV modules on a loge scale near the coastal areas to replace the electricity amount that generating by the current nuclear power plants. Many environmentalists and scholars warn that this energy transformation policy will deteriorate the quality and put negative impact on the ecosystem of coastal wetlands. This research first applies the contingent valuation method (CVM) to estimate people's willingness to pay (WTP) for maintaining the Sihcao Wetland at status quo, and applies the choice experiment (CE) to estimate people's preference for 7 attributes of the coastal wetland. Then, using the estimated utilities for various attributes from CE, we can estimate peoples' WTP for conserving Black-faced Spoonbills (one of 7 attributes). CE results show people's favor attributes include 'common bird species', 'rare bird species' and 'Black-faced Spoonbills', but other attributes like 'activity on wetland', 'wetland size', 'landscape' and 'industry level' are less favored. The estimated annual WTP is NT 8.98 billion for keeping Sihcao Wetland and NT 1.59 billion for Black-faced Spoonbills. We believe this research not only help people realize that how valuable of the ecosystem services provided by the Sihcao Wetland but also help the government to make right decision on whether to preserve or develop the Sihcao Wetland.

Keywords: Sihcao Wetland, Black-faced Spoonbills, ecosystem service, contingent valuation method, choice experiment

高美濕地陸蟹路殺調查與減災措施

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摘要

高美濕地野生動物保護區是台灣中部的濱海濕地，以其風景而聞名，近年來受到越來越多遊客的青睞，緊接而來的是對高美濕地野生動物的嚴重干擾。2016 年至 2018 年，我們針對高美濕地周圍的三段海堤進行了陸蟹調查。我們的研究結果顯示人類干擾對當地陸蟹族群產生嚴重的影響。在 2017 年的調查結果中，1,625 隻記錄到的陸蟹，有 54.8%為死亡個體，其中 29.8%來自於路殺死亡，且路殺死亡的陸蟹數量與調查當天通過海堤的車輛數呈顯著相關。非路殺螃蟹的數量佔 25.0%，且與海堤的形式或形狀顯著相關：垂直海堤更容易導致陸蟹死亡。2017 年我們在垂直海堤上試著利用兩種緩解結構來紓解垂直壁所造成的影響，並且與斜坡式海堤相比較。垂直式改良方式的第一類是將垂直洗石子海堤改為 75 度漿砌卵石壁，第二類是以咖啡豆麻布袋覆蓋垂直洗石子處理，結果發現在垂直式海堤中，麻布袋處理組具有較高的攀爬率，但斜坡式仍是有較高的成功率。而非垂直海堤的兩種類型為光滑斜坡與有草斜坡。雖然有草斜坡式海堤的攀爬率較高，但光滑式的斜坡海堤成功率較高。由現場的觀察推論，可能是入侵種長腳捷蟻（Anoplolepis gracilipes）在海堤中築巢造成的嚴重干擾。由 2018 年，截至 8 月份的調查結果，發現施放長腳捷蟻防治餌劑後，調查中發現的非路殺死亡陸蟹的數量有顯著減少。總結以上調查結果，對於海堤的設計，我們必須考慮住在海堤周圍區域的動物的棲地與行為，將有助於防止人工構造物對野生動物造成的傷害。

關鍵詞：高美濕地、陸蟹、路殺、垂直式海堤、生態友善工程

ROADKILL SURVEY AND MITIGATION OF THE LAND CRABS IN GAOMEI WETLAND

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Abstract: Gaomei Wetlands Wildlife Refuge is a coastal wetland in central Taiwan. Famous for its scenery, it also suffers from an increasing number of tourists, leading to a severe disturbance to the wildlife. From 2016 and 2018, we conducted the land crab survey on three sections of the seawall around Gaomei Wetland. Our results clearly indicated the serious problem of human interference on local land crab population. In 2017, 54.8% of the 1,625 crabs were found dead on the road, including 29.8% from roadkill, which significantly correlated to the number of passing vehicles. The number of non-roadkill crabs accounted for the rest of the 25.0% mortality, and was significantly correlated to the type or shape of seawall. Vertical seawall causes more death of the land crabs. We have included two types of mitigating structures on the vertical seawall which were rubble-mound and coffee bean sack cloth treatments. Results showed that the coffee bean sack cloth treatment has a higher climbing rate in the vertical seawall group. The two types of non-vertical seawall were smooth and grassy slopes. Although the climbing rate was higher in the grassy slope seawall, the smooth seawall had a higher success rate. This result might be due to severe interference by ants that nesting in the seawall. From the results of the survey in 2018 (June to August), we found that after the application of poison bait to yellow crazy ant (Anoplolepis gracilipes), the number of non-roadkill dead crabs was significantly decreased. In summary, for the design on the seawall, we must take into account the behavior of the animals in the surrounding areas of the seawall. It will be helpful in preventing extra animal sacrifice caused by the artificial structure.

Key Words: Gaomei Wetland, land crab, roadkill, vertical seawall, ecologically friendly engineering

臺灣西部海岸濕地碳儲存效益

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摘要

濕地提供了許多人類生活所需的生態服務，包括碳儲存、水質淨化、生物多樣性維持、水源涵養、微氣候調節及休閒遊憩提供等，因此一旦濕地遭到破壞，將為整體社會帶來龐大的成本。近年來隨著全球二氧化碳濃度的上升，濕地的碳儲存功能也逐漸受到重視。本研究透過實地生態調查取得海岸濕地之碳儲存量資料，估算臺灣西部 22 處海岸濕地共 26,420 公頃之碳儲存經濟效益。囿於研究經費，將臺灣西部海岸濕地大分為紅樹林、潟湖、潮間帶、鹽田、草澤等 5 個類型，針對各類型濕地擇一實地調查土壤與植物的碳儲存量，其他未實地調查之海岸濕地的碳儲存量則透過 Google Earth 及地理資訊系統量測該濕地中含有各類型濕地的面積，接著利用各類型有實地調查濕地之單位面積碳儲存量進行效益移轉，即可獲得未實地調查之海岸濕地碳儲存量。

實地調查結果發現：有紅樹林存在的濕地碳儲存量較高，其中四草濕地海茄冬區內的每公頃土壤碳儲存量最高約 13,318 公噸，而最低的淡水河挖子尾濕地水筆仔區每公頃也有 1,980 公噸碳；泥沙灘每公頃則僅有 408 公噸碳，因此濕地上的紅樹林有助於碳儲存量的累積。將碳儲存量轉換成二氧化碳儲存量後，臺灣西部 22 處濕地的二氧碳儲存量總共有 7,766 萬公噸，再以折現率為 5%、3%、2.5%下的二氧化碳社會成本現值（SC-CO2）估算，每年的碳儲存效益分別為新臺幣 275 億元、918 億元、1,377 億元。本研究結果可讓社會大眾與決策者在進行濕地保育或開發的討論時，瞭解濕地並非沒有價值，而回歸至濕地保育法提倡之明智利用，才能兼顧濕地生態永續與經濟效益。

關鍵詞：國家重要海岸濕地、效益移轉、碳儲存效益

CARBON STORAGE BENEFIT OF WESTERN COASTAL WETLAND IN TAIWAN

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Abstract: Wetlands provide many ecological system services for human beings, including carbon storage, water purification, maintaining biodiversity, water conservation, microclimate regulation, recreation , etc. Thus, wetland deterioration will bring huge cost to the whole society. In recent years, accompany with the accumulation of carbon dioxide in atmosphere, people has gradually recognized the importance of carbon storage function of wetlands. This paper aims to estimate the economic benefits of carbon storage for 22 western coastal wetlands in Taiwan, totally with 26,420 hectares. With limited research budget, this study conducted field surveys to measure the carbon storage of plant and soil for only each of the 5 different types of coastal wetlands-'mangroves', 'lagoons', 'intertidal zones', 'salt fields', and 'marsh beach'. Regarding the wetland without being conducted a field survey, we first applied Google Earth and geographic information system (GIS) to measure its areas that match with different wetland types, then we benefit transferred the estimated carbon storage amounts of per hectare for 5 different types of surveyed wetlands to estimate their carbon storage amount. The results from field surveys shows that the highest carbon storage of per hectare wetlands is 13,318 metric tons in the 'mangrove' and the lowest is only 408 metric tons in 'mud beach'. After converting carbon storage to carbon dioxide storage, the total amount of carbon dioxide stored in 22 western coastal wetlands in Taiwan was 77.7 million metric tons in total. We times carbon dioxide storage amount with the present value of the social cost of carbon（SC-CO2）at a discount rate of 5%, 3%, and 2.5%, the annual carbon storage benefit is NT$27.5, 91.8, and 137.7 billion, respectively. These values provide the public and decision makers to know that coastal wetlands are not worthless, and it is very important to use coastal wetlands wisely and make them sustainable.

Key Words: Taiwan's coastal wetlands, benefit transfer, carbon storage benefits

探討在台灣西部沿海地區受威脅台灣旱招潮蟹族群的遺傳變異

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摘要

台灣招潮蟹（Uca (Xeruca) formosensis）為台灣特有種，過去文獻中發現分別在許多河口與濕地有較大的族群存在，例如：台南曾文溪口、彰化縣伸港鄉濕地、新竹香山泥灘地等。但因為環境開發的壓力日以劇增，導致台灣招潮蟹族群的驟減。除了 1984 年與 1999 年等位酶的位點分析，少有分子證據來進行族群遺傳的研究與分析，過去的研究多以台灣招潮蟹的行為模式、棲地型態、外觀與覓食等研究居多。本研究目的為藉由較新的分子技術所提供的數據，研究台灣招潮蟹族群的遺傳結構。本研究在台灣西部沿岸七個濕地（香山、高美、伸港、線西、大城、麥寮、七股）採樣 280 隻台灣招潮蟹步足肌肉，藉由 DNA 指紋分析探討台灣招潮蟹族群的遺傳變異與核酸多樣性（π）與基因型多樣性（Hd）。結果顯示，台灣招潮蟹族群中的伸港、高美、線西族群核酸多樣性相對其他族群低（π = 0.075），麥寮、大城、七股、香山的族群核酸多樣性較高（π = 0.206），也檢測到基因型多樣性（Hd）平均為 0.97。此外，藉由 AMOVA 分析結果顯示台灣招潮蟹族群內也存在著很高的遺傳變異，主座標軸分析（PcoA）與遺傳結構分析也顯示台灣招潮蟹族群之間沒有太大差異。因此，建議台灣招潮蟹的棲地應持續予以保留與經營，藉由目前族群仍有較高的遺傳變異與核酸多樣性（π = 0.141），或許有助於台灣招潮蟹族群數量的逐漸恢復。

關鍵字：台灣招潮蟹、DNA 指紋分析、核甘酸多樣性、基因型多樣性、遺傳變異

GENETIC VARIABILITY IN THE THREATENED POPULATIONS OF UCA (XERUCA) FORMOSENSIS IN THE WEST COAST OF TAIWAN

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Abstract:The fiddler crab Uca (Xeruca) formosensis is an endemic species of Taiwan. More than a decade ago, large populations were reported in the wetlands of Tzenwen estuary, Shankang, and Shianshan mudflats. However, due to the decrease in natural habitat for the development of human use, the population of U. formosensis gradually decreased. Until recently, there is a growing consensus to protect its habitat. However, studies on U. formosensis were mostly descriptive, focusing on the morphology, the foraging and social behavior, and the habitats. There is currently no report on the population genetic analysis of U. formosensis, except two studies using allozyme analysis in 1984 and 1999. Therefore, it is necessary to determine the genetic structure and gene diversity in the population of U. formosensis. The present study aimed to understand population genetic structure and genetic variation of U. formosensis from new molecular evidences. Thus far, we have collected 280 samples from seven wetland habitats located along the west coast of Taiwan. We examined the genetic variability of U. formosensis through TE-AFLP with the aim to identify the genetic diversity of U. formosensis populations. Using the information on the genetic variations, the nucleotide diversity of Sainsi, Gaomei, Shengang populations (π = 0.075) was also lower than those of the four populations, and showed a marked high haplotype diversity (Hd =0.97). Uca (Xeruca) formosensis have 93% genetic variation within population. The results of either population structure or PCoA analyses and population structure did not differ significantly among populations. In summary, with the high genetic variation and gene diversity, there is still a chance to recover the population of U. formosensis if there is a better plan for habitat restoration.

Key Words: DNA fingerprinting, haplotype diversity, nucleotide diversity, genetic variation

臺灣桃園殼狀珊瑚藻藻礁大型海藻新紀錄與多樣性

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摘要

台灣面積最大的藻礁-「桃園藻礁」，位於桃園市大園區、觀音區及新屋區海岸，這段綿延 27 公里的礁體主要是由殼狀珊瑚藻所建構而成。除了殼狀藻（珊瑚藻目與耳殼藻目中的殼狀藻）以外，本研究聚焦於其它的大型海藻多樣性，在白玉藻礁、大潭藻礁（G1、G2）、觀新藻礁（永興、永安），共五個樣點的潮間帶低潮位區域，於 2017 年五月、2018 年三月與四月退潮時進行三次調查。本研究調查紀錄到 3 種綠藻與 14 種紅藻，共有 17 種大型海藻，其中 15 種是首次在桃園藻礁被紀錄到，其中包含兩種台灣新紀錄種，*Gelidiophycus hongkongensis* 與 *Gelidium yangmeikengense*。整合過去紀錄的 7 種大型海藻，目前在桃園藻礁大型海藻共紀錄有 22 種（4 種綠藻與 18 種紅藻），分屬於 3 個綱、10 個目、14 個科、16 個屬。本研究雖然只有三次的野外調查，卻大大提升桃園藻礁的海藻多樣性，讓我們了解到過去對於該地區生物多樣性的低估，另外新紀錄種的發現也突顯桃園藻礁生態系的獨特性，無論就其地理位置與自然棲地，對於臺灣海洋生態都是不可或缺的一塊寶地。

關鍵詞：桃園藻礁、海藻多樣性、新紀錄、臺灣

NEW RECORDS AND DIVERSITY OF SEAWEED IN THE TAOYUAN CCA REEF OF TAIWAN

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Abstract: Taoyuan CCA (Crustose Coralline Algal) Reef is the largest known modern algae reef ecosystem in Taiwan. It is a 27-kilometer long reef along the coastline of Taoyuan City. Crustose coralline algae (CCA) is the main reef-building organisms. In order to understand the seaweed diversity (except the crustose algae in Corallinales and Peyssonneliales) in Bai-Yu, Da-Tan and Guan-Xin algal reefs. In this study, the survey were conducted at low-tide time in Bai-Yu, Da-Tan (G1and G2) and Guan-Xin, (Yong-Xing and Yong-An) on May 2017, March 2018 and April 2018. There were seventeen species including three Chlorophyta and fourteen Rhodophyta. *Gelidiophycus hongkongensis* and *Gelidium yangmeikengense* are considered new records for Taiwan. A total of twenty-two species for Taoyuan algal reef are reported here, including seven algal records from previous studies and fifteen newly discovered taxa in our survey. The data showed an extension of seaweed diversity only from few survey that indicated the diversity was under estimated in the past. In addition, the discovery of the new records also highlights the importance and uniqueness of Taoyuan CCA Reef.

Key Words: Taoyuan algal reef, seaweed diversity, new records, Taiwan

105-106 年度夢幻湖重要濕地基礎調查成果

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摘要

夢幻湖國家重要濕地是臺灣特有種臺灣水韭(Isoetes taiwanensis)唯一自然棲地，但面臨自然與人為因子干擾與威脅。陽明山國家公園管理處自 2006 年起持續進行棲地維護與管理以及生態監測。本計畫主要工作是夢幻湖生態調查，監測水質、植物與陸域脊椎動物(包括: 鳥類、哺乳類、兩棲類、爬蟲類、魚類等)。除現場調查外，並搭配自動相機輔助調查，瞭解棲地維護管理及生態現況，分析各環境因子與臺灣水韭生長之相關性，釐清影響夢幻湖國家重要濕地生態變化的驅動力，藉以提出生態系管理對策。自 2016 年 10 月起至 2017 年 9 月於陽明山國家公園區內調查，植物調查共記錄 32 科 47 屬 50 種植物，包括 1 種蘚類植物、9 種蕨類植物、1 種裸子植物和 39 種被子植物。動物調查總共記錄 16 目 42 科 59 種野生動物，其中哺乳類 7 目 9 科 10 種、鳥類 7 目 25 科 37 種、兩棲類 1 目 3 科 6 種、爬蟲類 1 目 5 科 6 種，其中新記錄了臺灣 II 級保育類哈特氏蛇蜥(Dopasia harti)。調查結果顯示植物調查與過去研究結果相近，但水質更佳；動物共記錄 15 種保育物種，顯示陽明山國家公園夢幻湖地區生態資源豐富，維護成效佳，但仍須持續監測，補足夢幻湖地區物種調查，例如水棲昆蟲。

關鍵詞：臺灣水韭、夢幻湖國家重要濕地、鳥類、哺乳類、兩棲類

FOUNDENMENTAL INVESTIGATION OF MENGHUAN LAKE WETLAND IN 2016-2017

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Abstract: Menghuan Lake is the wetland of national importance, where is the only natural habitat for the endemic pteridophyte Isoetes taiwanensis. However, the wetland has been facing disturbance and threat from natural forcing and human activities. The Yangmingshan National Park Headquarters started to manage the habitat and continuously monitor the key environmental factors since 2006. This project aimed to assess the current ecological condition in Menghuan Lake. We monitored water quality, aquatic plants and terrestrial vertebrates (such as mammals, birds, reptiles, amphibians and fish). In addition, we used automatic camera-assisted investigation to assess the habitat condition and to explore the key factors regulating the coverage of Isoetes taiwanensis and the biodiversity of Menghuan Lake. In total, 47 families and 50 species of plants, 9 families and 10 species of mammals, 25 families and 37 species of birds, 3 families and 6 species of amphibians, 5 families and 6 species of reptiles have been documented in this study. The endemic species Dopasia harti classified Protection Category II was newly discovered in this area. Our results showed that water quality and aquatic plant coverage in the wetland remained oligotrophy and similar conditions compared to previous studies last year. In total, 15 protected wild animals were recorded this year, indicating that natural resources in Menghuan Lake are abundant and maintain well conditions. It is needed to continue monitoring and filling the gap of the biodiversity recordsin Menghuan Lake.

Key Words: Isoetes taiwanensis, Menghuan Lake Wetland of National Importance, mammals, birds, amphibian

濕地友善生產環境推動-以馬太鞍濕地為例

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摘要

本研究以花蓮縣馬太鞍重要濕地保育利用計畫範圍為基地，於兼顧濕地生物多樣性及地方產業發展前提下，結合地方力量推動友善環境生產，營造馬太鞍濕地環境，落實明智利用，並提供未來各濕地推廣友善環境參考。

面對私有地居多的濕地環境，透過在地的訪視，蒐集地方意見，從地方關心議題出發，針對濕地農業困境及阿美族部落 palakaw 漁法傳承等主題切入，提高在地關注及參與意願，並結合專家及農業技術單位將適地適種、多樣性生產環境、外來魚種移除等友善環境概念轉化為可操作模式；由在地部落及社群協助號召有興趣的民眾組成議題小組，透過盤點訪視、工作會議、參與式工作坊、試驗田操作、巡守隊組織等多樣形式嘗試建立夥伴關係，並結合滾動式討論，導引可能的協調及推動機制，促成在地部落參與濕地經營管理平台籌備，共同為守護濕地環境努力。

關鍵詞：國家重要濕地、馬太鞍濕地、友善生產環境。

PROMOTING THE CONSERVATION AND ECO-FRIENDLY USE OF WETLANDS - IN THE CASE OF FATAAN WETLAND

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Abstract: In the case of project demonstration area of Fataan Important Wetland, the study reported a wetland participatory management case encouraging people eco-friendly use of wetlands in order to achieve the balance between biodiversity conservation and local development in Hualien County, .

To overcome the challenge of private ownership of Fataan Important Wetland, the study showed the successful strategies used by the project team: (1) increasing the concerns and motivation of local community through local visit, collect local opinions and discussion on local issues such as Palakaw fishery ; (2) developing the local eco-friendly production mode for creating more biodiversity environment with suitable planting and alien species removal. (3) creating the partnership in the tribe through participatory workshop, trial field and community watch. The results showed these strategies successfully encouraged the local tribes to the participate in the wetland management platform preparation and work together for the future of the wetland.

Key Words:National Important Wetland、Fataan Wetland、Friendly production environment.

2012-2017 年高美濕地雲林莞草分布範圍變化

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摘要

雲林莞草（*Bolboschoenus planiculmis*）為多年生的鹽生草澤植物，提供底棲生物覓食及棲息的場所。雲林莞草目前在臺灣本島分布於西部至東北部河口或沿岸，高美濕地擁有目前全臺面積最大的族群。然而，高美濕地的雲林莞草族群受到灘地陸化的影響，以及入侵種互花米草（*Spartina alterniflora*）的競爭，導致其分布範圍逐漸減少。「臺灣維管束植物紅皮書名錄」在 2017 年將雲林莞草列為瀕危級(EN)植物。為了瞭解高美濕地雲林莞草生長範圍受到陸化及入侵種互花米草的影響，本研究於臺中市高美濕地進行長期監測。本研究自 2012 年 1 月起，每月進行雲林莞草生長範圍調查。調查以人力徒步方式，手持 GPS 軌跡紀錄器，繞行雲林莞草生長區域，將繞行軌跡以 ArcGIS 繪製成圖並計算面積。六年間的調查結果顯示，雲林莞草分布範圍逐漸外移，將 2012 年及 2017 年的調查結果疊圖，分別比較高美二號海堤、高美一號海堤及番仔寮海堤三區近岸側雲林莞草範圍向外推移的程度。結果發現高美二號海堤區植株平均每年向外推移約 13.5 公尺，高美一號海堤區植株平均每年向外推移約 11.2 公尺，番仔寮海堤區植株平均每年向外推移約 19.6 公尺。

關鍵詞：高美濕地、雲林莞草、陸化

THE INVESTIGATION OF THE DISTRIBUTED VARIATION OF BOLBOSCHOENUS PLANICULMIS FROM 2012 TO 2017 IN GAOMEI WETLAND

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Abstract: The salt marsh *Bolboschoenus planiculmis* is a perennial plant which provides shelters to the benthos for feeding and hiding. *Bolboschoenus planiculmis* is currently distributed from the west coast to the northeast coast of Taiwan, and the largest population is found in Gaomei Wetland. However, the distributed range of *B. planiculmis* is decreasing due to the wetland reclamation and the invasion of *Spartina alterniflora.* In 2017, *B. planiculmis* was listed as endangered species by "The Red List of Vascular Plants of Taiwan". In order to analyze the effects of wetland reclamation and invasion of *S. alterniflora* on *B. planiculmis*, we conducted a long term investigation in Gaomei Wetland Since January 2012. The distribution area of *B. planiculmis* was monitored monthly by walking along the distributed edge of *B. planiculmis* with GPS tracker, and the distribution area surrounding by trajectory was calculated by ArcGIS (Geographic Information System). The results showed that the boundary of *B. planiculmis* moved continuously from the land to the sea. To compare the moving distance of *B. planiculmis* in the three different areas, the first Gaomei Seawall, the second Gaomei Seawall and the Fanzailiao Seawall, we overlaid the map of the range of *B. planiculmis* each year from 2012 to 2017. The results showed that the boundary of *B. planiculmis* moved away from the second Gaomei Seawall in an average distance of 13.5 m per year. Similar situation was found in the first Gaomei Seawall and the Fanzailiao Seawall, and the average distance is 11.2 m and 19.6 m, respectively.

Key Words: Gaomei Wetland, *Bolboschoenus planiculmis*, reclamation

以路殺調查資料建立估計高美濕地番仔寮海堤紅螯螳臂蟹(Chiromantes haematocheir)有效族群數量之方法

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摘要

降海釋幼型螃蟹在繁殖期間會遷徙至海岸或潮間帶等感潮區釋幼。海岸線道路拓寬及海堤形式改變等人為工程，可能會增加螃蟹跨越道路及海堤抵達海岸的時間與難度，進而提高被車輛路殺的風險。本實驗室自 2016 年起，在新月及滿月後的 3-5 天，每次 6 人，進行高美濕地番仔寮海堤內側螃蟹的路殺調查。結果顯示，遭路殺的螃蟹佔總調查隻數的 50%。為進一步探討路殺對於螃蟹族群的壓力，實驗室針對當地遭路殺最為嚴重的紅螯螳臂蟹(Chiromantes haematocheir)以捉放法進行族群估算。然面臨回收個體數量較少及標記脫落等困難，故本研究目的是以調查所計數之紅螯螳臂蟹抱卵雌蟹數量，建立估計當地有效族群數量的方法。本研究以下述兩點作為基礎建立估計有效族群之基礎，(1)假設已達性成熟的雌蟹皆會在繁殖週期至海岸釋卵。(2)Saigusa 所提出紅螯螳臂蟹在繁殖週期內平均釋卵約 2 次，第一次釋卵約 30 天後會進行第二次釋卵，且釋卵個體數量在大潮時較多，小潮時最少。在進行調查時，盡可能的計數紅螯螳臂蟹抱卵雌蟹數量，將數量加總後校正重複釋卵數量，計算出紅螯螳臂蟹性成熟雌蟹的估計數量，並以雌雄比計算性成熟雄蟹的估計數量，最後以 Wright 所提出之有效族群公式計算出番仔寮海堤內側可能的紅螯螳臂蟹有效族群數量。以 2016 – 2018 年調查結果顯示，番仔寮海堤內側紅螯螳臂蟹有效族群數量大約為 3000 - 5000 隻。未來希望能合併抱卵雌蟹體長體重分佈，進一步估計當地的族群數量。

關鍵詞：路殺、有效族群估算、紅螯螳臂蟹

ESTABLISHING AN ESTIMATION METHOD FOR EFFECTIVE POPULATION SIZE OF CHIROMANTES HAEMATOCHEIR NEAR FANZAILIAO SEAWALL IN GAOMAI WETLAND BY ROADKILL DATA

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Abstract: Land crab will migrate to coastal or intertidal area for spawning during breeding season. Road construction and widening near coastal region and seawall modification increase the difficulty and time needed for crabs to reach coastal zone and may increase the risks of roadkill. We have investigated the roadkill of crabs near Fanzailiao seawall in Gaomai wetland since 2016. The results showed that the amount of roadkill crabs accounts for about 50 percent of the mortality during investigation period. To examine the degree of roadkill pressure to the local population of crabs, we estimated the population size of Chiromantes haematocheir which contributed the largest number of the roadkill in 2016 and 2017 by capture-recapture method. But the rare recapture event and the loss of the marking may reduce the accuracy. The purpose in present study is to establish an estimation method for effective population size of Chiromantes haematocheir near Fanzailiao seawall by roadkill data. The estimation method is based on the following two assumptions. First we assume that all mature female will migrate to coastal area for spawning during breeding season. Second, according to previous study by Saigusa (1980), we assume female will spawn twice during breeding season and the interval of spawning is about 30 days. In addition, the largest and the least amount of spawning crabs are near spring tide and neap tide, respectively. According to these assumptions, the effective population size of Chiromantes haematocheir was estimated by the following steps. First we count the amount of ovigerous crabs as much as possible during investigation period. We need to adjust the data for the repeated spawning and estimate the amount of mature males from the amount of mature females and the sex-ratio. The effective population size of the crabs was finally concluded. Our results show that the effective population size of Chiromantes haematocheir near Fanzailiao seawall is about 3000 – 5000 individuals in 2016 - 2018. In the future, the estimation will include the size distribution for better accuracy.

Key Words: Roadkill, effective population size estimation, Chiromantes haematocheir

桃園藻礁蟹類組成

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摘要

藻礁的外觀不起眼，過去常被認為是死亡的珊瑚礁而被忽略。台灣目前最大的藻礁分布在桃園，海岸長度約 27 公里。藻礁是由殼狀珊瑚藻經歷七千年的生長堆疊形成，相較其他類型的岩礁生態系，藻礁質地較軟，孔隙也較多，適宜多種海洋生物棲息，包含種類繁多及數量龐大的蟹類。本研究選擇桃園白玉至永安藻礁進行螃蟹族群調查。調查方法依不同體型大小區而異，體型大於 1 公分的個體以定點觀察法調查三個 1 平方公尺內的螃蟹種類及數量；體型小於 1 公分的個體，每個樣點採取兩個半徑 5.5 公分深度 10 公分的立方公分礁體，帶回研究室將礁體分解後，取出螃蟹進行種類及數量計數。目前研究結果發現在晚上較容易觀察到螃蟹，體型大於 1 公分的個體共記錄到 3 種，記錄到數量最多的物種是兇猛酋婦蟹（*Eriphia ferox*），大潭 G2 區記錄到最多物種；體型小於 1 公分的個體共記錄到 5 種，記錄到最多的物種是小型小相手蟹（*Nanosesarma minutum*），保生地區記錄到的物種數最多。

THE SPECIES COMPOSITION OF CRABS IN TAOYUAN ALGAL REEFS

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Abstract: Algal reefs are easily ignored as dead coral reefs due to its plain looking feature. The largest algal reef ecosystem is found in the coast of Taoyuan city with a 27 km crustose coralline algae coast in length. It is known that algal reefs in this area are formed by crustose coralline red algae during the past 7000 years. Algal reefs are soft with more crevices than other hardground shore. It is a suitable habitat for marine species, including crustaceans. In this study, the study site is from Beiyu to Yougan which about 10 km. We conducted two methods for crustacean survey, depending on the body size of the crabs. For the carapace width larger than 1 cm, we recorded all the crabs in three of the 1 m2 quadrat. When the carapace width is smaller than 1 cm, we took two cores with 5.5 cm in diameter and 10 cm in height and recorded the crabs inside. We found crabs can easily be found in the night. We have recorded 3 species with body size larger than 1 cm. The largest population is Eriphia ferox. Datan G2 has the highest species diversity for larger crabs. We recorded 5 species with body size smaller than 1 cm. The largest population is Nanosesarma minutum. Baosheng has the highest species diversity for smaller crabs.

陽明山國家公園夢幻湖自然保留區沉積速率初探

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摘要

夢幻湖位於北臺灣的陽明山國家公園內，標高為870公尺，總面積約1公頃，是國內重要的高山湖泊，也是臺灣特有種生物「臺灣水韭」的主要生存環境。依據劉聰貴(1990)、陳淑華(2010)的鑽孔資料顯示，夢幻湖的湖底沉積物約有 4 公尺深，其生成年代距今約 6~7000 年。其形成原因應為岩屑崩落形成的堰塞湖（黃增泉，1983）。近年來由於降雨量的變化，夢幻湖水位變化極大，加上有機物長期蓄積，陸化威脅加劇，影響水生植物的生存。「夢幻湖及附近窪地之剖面分析及定年研究」由沉積物之厚度及年代計算出平均淤積速率，推測若湖區四周之沖積速率未因人為或自然因素而改變，且湖內植物無重大變化，夢幻湖約尚有 1500 年的壽命。

本研究以重力薄管採樣法，取得夢幻湖表層約 1 公尺深的沉積物標本，以 AMS 進行碳 14 同位素定年，並以定岩樣本深度回推其沉積速率。定年的標本為樣本中的落葉及部分植物殘體。定年結果在深 51 公分處距今 2630 年、深 10 公分處為 710 年。依此推算，每年的沉積速率約為 0.2 公厘，相對於太平山翠峰池的速率(汪良奇，2011)還要慢。

本研究另外監測夢幻湖的水位變化（施上粟，2017），依據水位下降速率的不同，疑似在 866.7 的(海拔)高度附近，可能有漏水點存在。此外，2018 年春季降水缺乏，夢幻湖發生長時間的乾涸。如果缺水超過 5 週，湖中的藜蘆會有生存危機，這是氣候變遷對夢幻湖環境帶來的衝擊之一。

關鍵字：湖泊沉積物、ＡＭＳ定年、陽明山國家公園

INDICATION OF LAKE SEDIMENTS AT DREAM LAKE, YANGMINSHAN NATIONAL PARK, TAIWAN

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Abstract: The Dream Lake of Yangminshan National Park, located at northern Taiwan which is formed about 6200 year ago because of landslide deposits. The size of Dream Lake is about 1 hectare at the height of 870m above sea level. As the Dream Lake is at volcanic area and face to the north-east Monsoon, the characters of the lake together with quillwort, which is an endanger species, become a very sensitive environment. According to the design of national park, the lake is classified as ecological area.

The 14C dating by AMS shows that the age of sediments is c.710 yrbp at 10 cm depth and c.2630 yrbp at 51cm depth. The deposition rate of the sediment is about 0.2 mm. The source of the sediments mainly from the decomposition of leaves and partly from the adjacent slope during typhoon periods.

This study also shows that there are some cracks or holes at 866.7m and lake water could leak from there very quick. This is an indicator for the protection of quillwort if the water deficiency for more than 5 weeks, the quillwort could be disappearing due to climate change. It will need more attention on management the quillwort at the lake.

The study demonstrates the results of the study.

Key words： Lake sediments; AMS age dating; Yanminshan National Park

國家重要濕地生態監測網建置之先期作業規劃

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摘要

本文探討各國家重要濕地需規劃生態重要基礎調查項目、調查頻率、調查位置及調查方法，以作為濕地生態監測網建置之先期作業規劃。濕地保育法施行後，目前共有 42 處國際級及國家級重要濕地，濕地保育法第 6 條規定主管機關應定期會同有關機關進行濕地生態、污染與周邊社會、經濟、土地利用等基礎調查。內政部營建署自 105 年起委任經營管理單位於每年度研提基礎調查建議書，針對已公告國際級、國家級重要濕地之生態、水質、土地利用，辦理調查作業，並訂有生態調查、水質調查及土地利用調查規範。惟鑑於各別濕地環境條件特色、應妥善管理之自然資源與生態功能均不相同，且國家財政預算投入效益及行政效率應予最大化，本文爰擬盤整 42 處國家重要濕地之各重要濕地之環境條件特色及應妥善管理之自然資源與生態功能，研擬重點基礎調查項目及調查頻率，並建議各濕地各項調查樣點設置及調查方法，以利資源精確效率化投入，並協助加速內政部營建署委任調查作業之行政審查時效，同時作為國家重要濕地生態監測網建置之先期作業規劃。

關鍵詞：國家重要濕地、生態監測網、調查樣點、調查頻率

THE PRIOR PLANNING OF ECOLOGICAL MONITORING SYSTEM FOR TAIWAN'S WETLANDS OF IMPORTANCE

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Abstract: This study aims to formulate ecological basic investigating strategy, including survey items, survey frequency, survey positions and survey methods, of Taiwan's wetlands of importance. After the law of conservation of wetlands went into effect, 42 wetlands of national importance were announced in Taiwan. The competent authority should regularly exercise basic survey, including wetlands ecology, pollution, sociology, economic and land utilization. From 2016, Construction and Planning Agency, Ministry of the Interior appoints the units of management to submit the suggestion of basic investigation every year. As the difference of environmental characteristics between wetlands, this research sorts out 42 national important wetlands' respective environmental characteristics. And besides, national budget and administrative efficiency should achieve the best outcome. Therefore, this study drafts ecological basic investigating projects that included survey items, survey frequency, survey positions, and survey methods. This study attempt to help the government about accurate investment and also provide some guidance for the management of wetlands.

Key Words: Taiwan's wetlands of importance, Ecological monitoring system, Survey position, Survey frequency

壽山地區劣化棲地植生復育一年期成效

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摘要

本研究於高雄壽山地區針對遭民眾私闢的休息區進行植生復育，希望恢復該區域之植生狀態，亦初步評估壽山地區現存採礦跡地植被進行植生復育之執行方式及復育方向。2018 年 9 月，栽植完成約 1 年後，27 種原生樹種存活率的優劣出現大幅差異。存活率高於 70%的樹種除了有恆春厚殼樹、月橘及黃荊等栽植現場鄰近普遍出現的樹種，還有克蘭樹、白雞油及無患子等樹種。存活率低於 40%的樹種為大葉雀榕、軟毛柿、茄冬、山豬枷、大葉楠及構樹。存活率差異可能與樹種應付乾旱的能力及是否受到動物啃食偏好具有關係。另外，苗木栽植位置的樹冠鬱閉度也呈現些微影響，鬱閉度較高(>60%及 31-60%)的類群有較低的死亡值(0.29 及 0.44)，低鬱閉度(<30%)類群則死亡值較高(0.76)。栽植後每 3 個月進行監測，一年中死亡值最高的時期是 3-6 月(1.22)，此時期為乾季末期，土壤水份最缺乏且空氣溫度最高，植物體的水分赤字最大，可能是造成死亡值增加的主要原因。死亡值在 6-9 月時最低，為 0.23。栽植方式除了一般栽植方式，另外也施用保水劑及加寬植穴進行比較，結果顯示 3 種栽植操作方式的死亡值沒有差異。

關鍵詞：生態復育、死亡值、適口性、耐旱、保水劑

ONE YEAR SEEDLINGS GROWTH PERFORMANCE ON DEGRADED STAND OF SHOUSHAN AREA

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Abstract: This project was conducted on non-official rest area at Shoushan national nature park in Kaohsiung city, in order to rehabilitation the plant cover and to evaluate the suitable restoration method for after-mining area in Shoushan. At Sep. 2018, about 1 year after planting, 27 indigenous tree species have had different performance in their survivor. Some common species of nearby area, *Ehretia resinosa*, *Murraya exotica* and *Vitex negundo*, and other less common indigenous species *Kleinhovia hospital, Fraxinus griffithii*, *Sapindus mukorossi* have survival rates higher than 70%. *Ficus caulocarpa*, *Diospyros eriantha*, *Bischofia javanica*, *Ficus tinctoria*, *Machilus japonica* var. *kusanoi* and *Broussonetia papyrifera* have survival rates less than 40%. The difference of survival rates among species may contributed to species with different ability to tolerant drought and with different palatability of their leaves. The crown closure rate of each individual may have slight influence on mortality. Groups with higher crown closure rates (>60% and 31-60%) have lower mortality (0.29 and 0.44), and group with lower crown closure rate (<30%) have higher mortality (0.76). After planting, the tagged seedlings were inventoried every 3-month. The period of May to Jun. have highest mortality (1.22), and period of Jun. to Sep. have lowest mortality (0.23). Besides the normal planting method, two different operating method, additive of super absorbent polymer (SAP) and enlarge the planting hole, were introduced to promote the establishment of seedlings. But the mortality of three operating method have no significant difference.

Key Words: Ecological restoration, mortality, palatability, drought, super absorbent polymer(SAP)

建立台灣濕地的指標植物清單

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摘要

濕地辨識與濕地範圍劃設是濕地管理的基礎，在美國採用濕地指標植物、水文與土壤三項指標做為劃設濕地之依據。而因為透過濕地植物指標做為劃設濕地之依據在野外操作有便利性，本研究提出以水生植物生活型之方法，綜合美國濕地植物類型之定義，建立台灣濕地植物清單。

本研究運用植物的根部與葉片適應飽合水環境的狀態，定義水生植物生活型類群。使用 2010 至 2012 年間，於台灣本島海拔一千公尺以下的沿海濕地、河川、溪流溝渠、水田與湖泊等濕地調查之植物種類，依植物根部與光合作用器官（通常為葉片）在水中的位置，將植物根部細分成：水中漂流、水底紮根及陸生；葉片位置則分成：浮水、挺水與沉水。由此歸納出六個水生植物生活型：1.根部懸浮－葉片沉水、2.根部懸浮－葉片浮水、3.根部懸浮－葉片挺水、4.水底紮根－葉片沉水、5.水底紮根－葉片浮水、6.水底紮根－葉片挺水。另外區分一陸生型：7.根部陸生-葉片挺水。

一物種可兼有兩種以上生活型，其中兼有水生及陸生之生活型者為廣義水生植物；只能水生者為狹義水生植物。結合美國濕地植物類型定義所區分之五個不同濕地類別：絕對濕地（OBL，水生植物出現在濕地的比例為 99%）、兼性濕地（FACW，67-99%）、兼性（FAC，34-66%）、兼性高地（FACU，33-1%）、高地（UPL，1%）。結果本研究建立 528 種台灣濕地指標植物，狹義水生植物 106 種幾乎全是 OBL（99.1%），廣義水生植物 91 種多為 FACW 或 FAC（98.9%），非水生植物 331 種則大多為 FAU（81.9%）。

水生植物生活型與濕地類型有密切關係，故以生活型方法建立之濕地指標可應用於辨識濕地範圍等濕地管理工作。

關鍵詞：光合作用、水生植物、生活型

ESTABLISHMENT OF TAIWAN WETLAND VEGETATION LIST FOR WETLAND INDICATORS

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Abstract*:* Wetland identification and delineation is the basis of wetland management. In the United States, it is executed through the wetland indicators of vegetation, hydrology and soil. Due to the convenience of applying vegetation as wetland indicators in fields, it is proposed a tentative Taiwan wetland vegetation list, based on the life forms of aquatic plants, and compared with the list based on the definition of vegetation categories of wetland indicator.

The life-form groups of aquatic vegetation are defined by the adaption of roots and leaves (photosynthesis organs) of plants in saturated environment, and aquatic life-type groups. Three life-forms groups of plant roots are categorized as suspended, rooted underwater, and rooted upland, where three life-form groups of plant leaves are also classified as floating, submerged, and emerging. Therefore, there are totally 6 life-form groups for aquatic vegetation and 1 life-form group for upland vegetation, that are 1. root suspended - leaf submerged, 2. root suspended - leaf floating, 3. root suspended - leaf emerging, 4. rooted underwater – leaf submerged, 5. rooted underwater - leaf floating, 6. rooted underwater – leaf emerging, and 7. root upland-leaf emerging. Totally 528 plant species surveyed in wetlands such as coastal wetlands, rivers, stream ditches, paddy fields and lakes below the height of 1000 meters in Taiwan from 2010 to 2012 were groups according to the above classification method.

More than two life forms may be applicable for one species. It is known that there are two definitions of aquatic vegetation, strict definition and generalized definition. If all life forms of a vegetation species are among the six life-form groups of aquatic vegetation, then it can be defined as aquatic vegetation by either definition. However, if one of life forms of a plant species is the upland life form, then it is regarded as aquatic vegetation only when the generalized definition is considered.

There are five vegetation categories in the manual of wetland indicators in the United States according to the occurrence of a vegetation species in wetlands, which are obligated (OBL, 99% of occurrence in wetlands), facultative wetlands (FACW, 67-99%), facultative (FAC, 34-66%), facultative upland (FACU, 33-1%), and up land (UPL, 1%). Among the 528 vegetation species in the tentative proposed list for Taiwan wetland indicator, 106 species of narrow aquatic plants were almost all OBL (99.1%), where 91 species of general aquatic plants were mostly FACW or FAC (98.9%), and 331 species of non-aquatic plants were mostly FAU. (81.9%).

The aquatic plant life forms are closely related to the wetland types. Therefore, the wetland indicator established by the life-form groups can be applied to wetland delineation and wetland management.

Keywords: photosynthesis, aquatic vegetation, life form

溪流垂直濕地系統之保育經營推動-以台北市雙溪為例

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摘要

從源流至中下游河道再到河口，從兩側濱溪植被到主流河道。溪流生態環境受其河相影響，具有縱向與橫向，時空多樣性之梯度變化特性。形成一垂直變化之濕地系統，與獨特之生態廊道；具有連續性變化之生態結構與功能，生物及化學過程。台灣本島以中央山脈為主要分水嶺，概分為 131 個主要水系，東西分流入海。短而急的溪流河川系統也建構了台灣森林與淡水濕地生態系統之多樣性。

陽明山國家公園為火山地質地貌，其溪流由大屯火山系，向四方放射形成時空壓縮之特殊垂直溪流生態棲地。又因穿越過國家公園與都市計畫不同土地使用分區，其水岸溪流之利用亦呈現多樣性。

本文以位於台灣北部之台北市雙溪為研究範圍。透過上中下游連續性觀點，分析探討溪流全域，上中下游各河段之環境特性，及保育管理目標課題。並嘗試結合區域合作夥伴，檢討研議序列之保護復育與經營管理策略行動。以逐步推展，確保溪流環境及其垂直濕地系統之生態功能永續與合理利用。

上游以陽明山國家公園、北市內雙溪自然中心、與溪山、菁山、平等里為主，結合溪流保育管理與淺山地方創生策略推動。中游以故宮博物院、台北市政府、東吳大學與沿岸社區為主，關注溪流水質汙染與親水遊憩環境與功能提升。下游則結合國立科學教育館等重要科學教育遊憩機構與沿岸社區，再現河口濕地環境，創造優質之溪流教育與遊憩服務功能與空間。營造串聯雙溪之垂直濕地系統，建構台北市區之生態遊憩廊道，以及河川自然教育中心。

關鍵詞：溪流、垂直濕地、溪流保育與經營管理

CONSERVATION AND MANAGEMENT OF A VERTICAL RIVER WETLAND SYSTEM – CASE STUDY OF TAIPEI SHUANGXI RIVER

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Abstract: The ecological environment of a river is influenced by fluvial geomorphology. Gradient characteristics of spatial and temporal diversity can be found both parallel to and perpendicular to the river. These are not limited to just the waterway, but also include the riverbank vegetation alongside. Together, they form a vertically changing wetland system and a unique corridor that has continuously varying ecological structures and functions by means of biological and chemical processes. The Central Mountain Range of Taiwan's main island serves as its main watershed. There are about 131 major water systems flowing east or west into the sea. These short, rapid-flowing streams and river systems produce the diverse forests and freshwater wetland ecosystems of Taiwan.

Yangmingshan National Park is a volcanic geological landform, its streams start from the Datun volcanic system and radiate into a special vertical stream ecology that has been spatially compressed over time. There is diverse usage of these streams as they flow through different land-use plans of the national park, Taipei and New Taipei city.

The research scope of this article is focused on Shuangxi, Taipei City, which is located in northern Taiwan. This paper analyzes and explores the environmental characteristics of the whole river basin (the upper, middle, and lower reaches of the river) and the objectives of conservation management. We also involved regional partners in reviewing and delineating subsequent protection and remediation strategies. Our aim is to systematically promote the ecological functions of the river environment for sustainable and rational use.

For the upper reaches of Shuangxi River which include Yangmingshan National Park, Taipei Inner Shuangxi Nature Center, and riverbank communities, stream conservation management and innovative local strategies were mutually promoted. The middle reaches of Shuangxi River covers the Palace Museum, Taipei City Government, Soochow University, and riverbank communities. The focuses here were placed on water pollution, hydrophilic recreation, and function enhancement. As for the lower reaches, important science education institutions (such as the National Science Education Center) and riverbank communities should work together to reproduce previously existing estuary environments and create high-quality river education and recreation services and spaces. In summary, we propose to construct the vertical wetland system of Shuangxi River as an ecological recreation corridor and education center of Taipei.

Key Words: rivers, vertical wetlands, river conservation and management

另類濕地概念：談「水方舟」校園空間活化

---以台灣一所小學為例

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摘要

本文以自傳俗民誌（autoethnography）研究方法，嘗試論述一所百年老校基於環境永續的生態觀點，近七年來持續展開的「水方舟」環境活化護樹行動方案。該校位於台灣北部的大漢溪畔石門水庫旁，以美國現代樹醫之父 Alex shigo（1985）「腐朽區隔理論」（CODIT, compartmentalization of Decay In Tree）樹木防禦機制做為依據；自 2011 年以來全校師生採取「自主性動手勞動」模式，持續對校園環境裡「人造硬鋪面」進行移除解構的「詩性勞動」。

方案目的在於還給校園老樹群良好根系棲地，以及為校園多樣生物棲地營造，帶來「眾生幸福」美好自然的荒野擬態。這一個「生態活化」的環境改造行動，筆者稱為「水方舟」方案。據以增加校園的透水性、含水性，以及營造樹木良好棲地的環境教育「詩性」觀點，讓學校基地真實成為富含水性的「另類濕地」，一個生態永續的眾生幸福場域。

學校，做為里山（satoyama）人們的社區中心，是環境教育的生態基地。濕地，做為里山萬物的生命聚落，是永續發展的生機所在。改善學校樹木的棲地生長條件，解構違反自然的校園人工鋪面，讓學校成為「水方舟」類濕地的環境友善場域，成為里山聚落「水環境」循環永續的幸福所在。

關鍵詞：另類濕地、水方舟、校園空間活化、CODIT 理論、眾生幸福

Alternative wetland concept: Talking about the activation of the campus of "Water Ark"

--- Take a primary school in Taiwan as an example

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Abstract: Based on the method of autoethnography, this paper attempts to discuss the ecological concept of a century-old school based on environmental sustainability, and the “Water Ark” environment activation tree protection action plan that has been continuously launched in the past seven years. The school is located next to the Shimen Reservoir on the banks of the Dahan River in northern Taiwan. It is based on the tree defense mechanism of the CODIT theory (Compartmentalization of Decay in Tree) by the father of American modern tree medicine, Alex Shigo (1985). Since 2011, the teachers and students of the school have adopted the "autonomous hands-on labor" model, and continue to carry out the "poetic labor" by remove and deconstruct "artificial hard pavement" in the campus environment.

The purpose of the program is to give the old trees of the campus a good root habitat and to create a beautiful and natural wilderness imitation of "all living beings well-being" for the campus's diverse biological habitats. This "ecologically activating" environmental transformation initiative, the author called the "water ark" program. According to the "poetic" view of environmental education to increase the water permeability and water content of the campus, and to create a good habitat for trees, the school base is truly a water-rich "alternative wetland", an ecologically sustainable life of all beings.

The school, as a community center for people in the satoyama, is an ecological base for environmental education. Wetland, as the life settlement for beings in the satoyama, is the vitality for sustainable development. Improve the habitat conditions of school trees, deconstruct the campus artificial pavement that violates nature, and make the school a friendly place for the "water ark" similar to wetland environment, which is the happiness of the "water environment" cycle in the settlement of satoyama.

Keywords: alternative wetland, water ark, activation of the campus, CODIT theory (Compartmentalization of Decay in Tree), all living beings well-being.

臺灣河灘地人工濕地之經營管理思維與發展

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摘要

行政院環保署自 2002 年河川污染整治年起，有鑑於公共污水下水道系統的緩慢進度，開始輔助地方政府在各污染水源附近、受污染的河川支流匯流處之河灘地建置水質淨化人工濕地。這些人工濕地中，有九處受列於內政部營建署之「國家重要濕地」系統。本研究自 2007 年起持續進行九處濕地之一的新竹頭前溪竹東高灘地第一、二期人工濕地植物變遷與水質淨化調查研究，目的為了解濕地完工後之營運管理與水質淨化成效關係，並試尋出未來接管率提升而污水不再進入河灘地人工濕地後之發展定位。研究方法是藉由 2007 至 2018 年記錄新竹頭前溪河灘地 10 年變遷觀察、濕地營運單位訪談以及九處人工濕地歷年成效評估成果進行交叉討論，歸納出臺灣不同區位環境的河灘地人工濕地營運，會產生各別與共同的問題。其中頭前溪人工濕地因長年淤積使河道變形、變窄，可容受水體以及水力停留時間已與完工階段具差異、各池區單元的淨化型水生植物經自然演替與維護管理已消失 3-7 種；九處人工濕地共通性問題包含水質淨化成效具有 SS 去除率偏低、BOD5 去除率偏低、NH3-N 去除率不穩定等表現；維護管理具有水生植物過剩與不足、清淤間隔期程過長、撈除植物就地覆蓋、棄置以及因臺灣河川特性影響淨化去除率等問題；規劃營運具有極端降雨頻度趨高、濕地場址遭極端強降雨破壞、人工濕地闢建無法避免的先天弱勢條件以及河川區域植物栽植限制等現象。河灘地屬河川與陸域環境之生態過渡帶(Ecotone)，位處於生態過渡帶上的人工濕地需具備非一般都市基礎設施之營運管理思維與方法。

因應未來污水下水道接管率提升以及極端降雨現象趨頻，建議將臺灣的河灘地人工濕地導入綠色基礎設施概念執行管理，將其定位保存並推廣再建造。

關鍵詞：人工濕地、極端降雨、可持續經營管理、生態過渡帶、綠色基礎設施

MANAGEMENT AND DEVELOPMENT MENTALITY OF TAIWAN'S CONSTRUCTED WETLANDS

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Abstract: Since the initiation of the river clean-up remedies by the Environmental Protection Administration in the year 2002, the slow development of public sewer systems prompted the EPA to begin assisting local governments in building water purification systems on constructed wetlands along various polluted water sources and river tributaries. Amongst these constructed wetlands, nine locations are designated as "Important Wetland Systems" by the Construction and Planning Agency of the Ministry of the Interior. Beginning in 2007, the authors have investigated the process of plant transitions and water purification in the first and second stages of constructed wetlands in the Zhudong Highland wetlands of the Hsinchu Touchien River, the purpose of which is to understand the correlation between management of the completed project and the results of the water purification, as well as to research the prospect of future wetland development once the sewage treatment rate has increased, and the waste water no longer enters the wetland.

The study methods included observations on the transition of the Hsinchu Touchien wetlands from 2007 to 2018, interviews with the wetland management units, and referring to historical evaluation reports and studies of the nine constructed wetlands since their operation. Cross discussion will be conducted regarding individual and common issues faced by the management of these different types of constructed wetlands. The study has revealed that after years of deposits, the first and second stages of the Touchien constructed wetlands have narrowed and deformed the river channel, and the water capacity and hydraulic retention times of the wetlands have differed significantly from the conditions when the construction was freshly completed; moreover, over 3~7 aquatic purifying plant species have disappeared in the treatment ponds due to natural evolution and maintenance operation. Common issues faced by the water purification process in the constructed wetlands included low suspended solid (SS) removal rate; low biochemical oxygen demand (BOD_5) removal rate and unstable ammonia-nitrogen (NH_3-N) removal rate; issues on

maintenance included surplus or deficiency of aquatic plants, long dredging intervals, disposal and coverage difficulties of removed plants at the scene, and the impact on water purification rate by the river's characteristics. For planning and operation issues, some common problems include high frequency of extreme rainfall, destruction of wetland sites by extreme rainfall, innate weakness of the constructed wetlands, and restriction on vegetation along riverside. The riverside zone is an ecotone that bridges the river and terrestrial environment, and such the constructed wetlands that reside in this region must have operation and maintenance mentality that differs from urban infrastructures.

Since the prevalence of sewage treatment and the frequency of extreme rainfalls are both expected to rise in the future, this study recommends that the management concept of green infrastructure shall be introduced to the constructed wetlands, in order to preserve their identity and to promote future renovation.

Key Words: constructed wetlands, extreme rainfall, sustainable management, ecotone, green infrastructure

鹹水型人工濕地與自然海岸濕地對藍碳碳匯功能之比較分析研究

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摘要

濕地可以從大氣中吸收貯存大量的 CO_2，通過光合作用及食物鏈，轉化為有機碳，大量累積於濕地的沉積物內。然而，透過呼吸、硝化與脫硝，以及甲烷發酵等作用，濕地亦將會釋出 CO_2，CH_4 和 N_2O 等溫室氣體。因此，濕地對於溫室效應，同時兼具有碳匯及碳源之效果。本研究將針對鹹水型人工濕地及自然海岸濕地，進行其碳匯功能之比較研究。研究中將選定屬於鹹水型紅樹林人工濕地之大潭濕地公園及援中港濕地公園，以及屬於自然鹽沼型海岸濕地之高美濕地等，做為研究的場址。研究採用動態浮動式氣罩針對 CO_2、CH_4 與 N_2O，利用非分散性紅外線吸收光譜法進行連續監測。經過氣體連續監測儀所測量到之溫室氣體濃度單位為 ppm，將轉換為排放通量(mg m^{-2} hr^{-1})。濕地淨初級生產量的推估係利用收集及量測濕地植體枯落物乾重，經由落葉淨初級生產量佔總淨初級生產量的經驗值比例(45%)，估算出紅樹林總淨初級生產量。濕地的淨碳收支量係將吸存於濕地內的碳量，減去三種溫室氣體釋出量，並轉換成二氧化碳當量(CO_2 eq)。其差值如為正值則判定該濕地具有碳匯功能，負值則表示濕地為碳源。根據研究分析結果，大潭濕地公園及援中港濕地公園所計算出的淨碳收支通量分別為-676 及+185 g CO_2 eq m^{-2} yr^{-1}，而分別呈現出其碳源及碳匯的效應，高美濕地計算出之結果則為+815 g CO_2 eq m^{-2} yr^{-1}，亦具碳匯功能。高美濕地的碳匯效果雖較其他二處人工濕地明顯，然而與其他自然型海岸濕地相較，其碳匯通量值仍較低。究其原因，可能是高美濕地附近有大排將污染的溪溝水排入所致。而其他二處人工濕地，大潭濕地公園主要功能處理海水養殖廢水，而援中港濕地公園則承受遭污染的典寶溪水及楠梓污水處理廠排放水。由水質分析結果得知，這些濕地的進流水中均含有不同濃度氮營養鹽的成分，在流入濕地內後，經由不完全脫硝作用，產生釋出 N_2O，該氣體溫室效應為 CO_2 的 265 倍，因而導致濕地溫室氣體釋出通量值增高，甚至高於濕地的碳吸存量，而呈現出碳源之效果(例如，大潭濕地公園)。因此，建議不論是自然或人工濕地，均需嚴格限制進流水中含氮營養鹽的排入，以增強濕地之藍碳碳匯功能。

關鍵詞：鹹水型人工濕地、自然海岸濕地、溫室氣體、藍碳碳匯功能

COMPARING ANALYSIS BETWEEN SALTWATER TYPE OF CONSTRUCTED WETLANDS AND NATURAL COASTAL WETLANDS ON BLUE CARBON SINK EFFECTS

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Abstract: Wetlands can sequestrate and store large amounts of CO_2 from the atmosphere, convert them into organic carbon through photosynthesis and food chains, and accumulate in sediments of wetlands. However, through the effects of respiration, nitrification and denitrification, and methane fermentation, the wetlands will also release greenhouse gases (GHGs) such as CO_2, CH_4 and N_2O. Therefore, the wetland has the carbon sink and carbon source on greenhouse effect, simultaneously. This study will investigate and compare blue carbon sink function between saltwater constructed wetlands and natural coastal wetlands. In the study, the Datang Wetland Park and the Yuanchungkang Wetland Park, both of which belong to the saltwater mangrove constructed wetland, and the Kaomei Wetland, which belongs to the natural salt marsh coastal wetland, will be selected as the research site. The study used a dynamic floating chamber to collect the three types of GHGs, and continuous monitoring by non-dispersive infrared absorption spectroscopy. The concentrations of GHGs measured were then converted to the emission flux (mg m^{-2} hr^{-1}). The estimation of the net primary productivity of wetland was first to collect and measure the dry weight of wetland plant litters, and then estimate the total net primary productivity of mangroves by the ratio of empirical number of 45%. The net carbon budget of the wetland is the amount of carbon that is sequestrated in the wetland, minus the release of the total flux of three types of GHGs converting to carbon dioxide equivalent (CO_2 eq). If the difference is positive, it is determined that the wetland has a carbon sink function, while a negative value indicates that the wetland is a carbon source. According to the analytical results, the net carbon fluxes of the Datang Wetland Park and Yuanchungkang Wetland Park were calculated equal to -676 and +185 g CO2 eq m^{-2} yr^{-1}, presenting carbon source and sink effects, respectively, while for Kaomei Wetland, the net carbon flux was calculated equal to +815 g CO2 eq m-2 yr-1 exhibiting blue carbon sink function. Although the blue carbon sink effect of natural type of Kaomei Wetland performed better than that of the other two constructed wetlands, its carbon sink flux was still lower than that of other natural coastal wetlands. The reason may be due to polluted water from a ditch discharging into Kaomei Wetland. While the other two constructed wetlands, Datang Wetland Park was mainly functioned as a treatment wetland treating mariculture

wastewater, while the influent of Yuanchungkang Wetland Park was from the polluted Dianbao Stream and the effluent from Nantzi Sewage Treatment Plant. According to the analytical results of water quality in this study, the influent for these wetlands contained different concentrations of nitrogen nutrients. Thus, the wetlands were measured some amounts of N_2O released through incomplete denitrification, which greenhouse effect is 265 times higher than CO_2 resulting in increasing GHG release flux values in the wetlands, and even higher than the carbon storage capacity of the wetland, and thus showing carbon source effect (*eg.* Datang Wetland Park). Therefore, it is recommended that no matter for natural or constructed wetland systems, nitrogen nutrients in the influents should be strictly limited discharged into the wetlands in order to enhance the blue carbon sink function of wetlands.

Key Words: blue carbon sink function, greenhouse gases, natural coastal wetland, saltwater type of constructed wetland

應用遙測於地景變遷分析－以桃園埤塘為例

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摘要

埤塘地景是人類與環境共生下的地景，符合拉姆薩公約與濕地保育法之濕地定義，具豐富的人文與生態價值，卻逐漸消逝。埤塘的定義為灌溉水池、魚池、蓄水池，且面積在 0.3 公頃以上者。本文以多源影像偵測埤塘地景變遷，以衛星遙測獲取目標物資訊，配合影像的分類可偵測地表使用情況，以獲取變遷資訊。研究中使用 1904 年臺灣堡圖數位化地籍資料、1969 年桃園地區 CORONA 衛星影像與 2004 年及 2014 年 SPOT5 衛星影像。SPOT5 衛星影像具有多光譜資訊，其中遠紅外光及多波紅外線能有效的將埤塘分類；而 CORONA 衛星影像為全譜態，其精細的解析度則提供了許多地表覆蓋之紋理特徵的表現，以紋理分析增進分類之正確率。單以紋理特徵作為分類依據時，能夠依照地物表面紋理將其分辨為各分類類別。在紋理分析各參數中，影響最大的為選擇移動網格尺；而在適用於遙測的六種紋理統計指標中，其分類成果差異不大。配合推理判釋之技巧，判釋地物提供的線索，清除多選出來被誤判為埤塘的農田像元雜訊。

由時政回顧與變遷形態圖發現，1904 年至 1969 年變遷原因為日治時期水利組織的建立使私人埤塘整併、桃園大圳竣工，並且因應台北快速發展下大型建設興起;1969 年至 2004 年石門水庫的建立與石門大圳的開通,使埤塘的功能式微，工業帶動都市發展而產生的變遷，都市由面狀逐漸擴張為帶狀，使都市邊緣的埤塘快速消失；2004 年至 2014 年桃園工業與發展至一個段落，台灣人民開始注重環境品質與台灣農業的永續，因此開始積極的保護埤塘，除了政府通過桃園市埤塘水圳保存及獎勵新生利用自治條例,許多社會組織也投身埤塘保護的工作中。

關鍵詞：埤塘、濕地、地景變遷、遙測、衛星影像

APPLICATION OF REMOTE SENSING IMAGES TO IRRIGATION POND CHANGE ANALYSIS IN TAOYUAN

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Abstract: The industry and commerce rose after the agriculture descended. The landscape of ponds which contains many historical value, humanistic value and ecological value is now gradually disappearing at Taoyuan tableland.

This research applies remote sensing images to observe the changing of the ponds. We can obtain the information from remote sensing images of objects indirectly and learn the usage of land by classifying the images. In this research, we apply Taiwan Bao-tu of Taoyuan in 1904, Corona satellite image of Taoyuan in 1969 and SPOT5 satellite image of Taoyuan in 2004 and 2014. The multispectral of near infrared and Short-Wave Infrared from SPOT5 satellite can classify the ponds effectively. However, the images of Corona satellite are panchromatic. We can rise the accuracy of the classification by texture analysis.

In the analysis of textural features, the most influential part is to choose the moving window size. Furthermore, there is unapparent difference between six methods of texture statistics that can use to remote sensing. Also, we can eliminate the clutter of farmland pixel form ponds pixel by the skill of inference.

As a result, from 1904 to 1969, the reason of transition is the development of water facilities that merging the ponds, the construction of the Tao-Yuan Irrigation Association and the vast construction for developing Taipei through the history and the change of patterns. Then from 1969 to 2004, because of the build of Shihmen Reservoir and Shihmen Irrigation Association, the function of the ponds gradually declined. Industrial development made the ponds near urban disappeared. The last part from 2004 to 2014, the industrial development in Taoyuan reached to the ceiling and people began to aware the importance of our environment and the sustainable development of the agriculture in Taiwan. For this cause, people and many social organizations started to protect the ponds. The government also legislates regulation to protect the ponds.

Key Words: pond, wetlands, landscape change, remote sensing, satellite imagery

不同水門操作策略對七股鹽田濕地環境品質之影響

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摘要

七股鹽田濕地原為鹽業用地，總曬鹽面積達 1976 公頃。於 2002 年停曬後，成為水鳥棲息、覓食、繁殖及過冬的重要棲地。由於原為鹽業用地，七股鹽田濕地設有水道連通西面的潟湖，並設有水閘門，同時濕地內的各區也皆有水道連通，可透過水閘門的開啟並配合外海的潮汐漲退，進行排水或引水。然而，透過 2017 年水深及鹽度調查發現，濕地內有著雨季時水位過高、乾季時水量不足的問題，因此常常出現不利鳥類利用的情形，又或因長時間的日照曝曬而導致水體鹽分過高及水質不佳等問題。為了解濕地水位管理與水質改善的可行性，本研究藉由不同的水門操作策略，同時進行水位及鹽度調查，綜合評估以找出建議的水門操作方式，利於日後對七股鹽田濕地環境品質的經營與管理。

關鍵詞：濕地、水位管理、鹽度、水門操作

EFFECTS OF DIFFERENT WATER GATE OPERATION STRATEGIES ON THE ENVIRONMENTAL QUALITY OF QIGU SALT PAN WETLAND

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Abstract: Qigu Salt Pan Wetland, was previously utilized for the salt industry, covering a total area of 1976 hectares. After the end of salt production in 2002, Qigu salt pan became wetlands as nature reclaimed the land. Today, these wetlands are an important habitat for water birds to inhabit, forage, breed and winter. Due to its original use for the salt industry, Qigu Salt Pan Wetland has waterways connecting all of the salt pan sections to each other and to the lagoon in the west, along with water gates which can control the flow. Through the opening of different water gates and the tidal rise and fall of the open sea, it is possible to manage water levels in the salt pans. However, from the surveys of water depth and salinity in 2017, there are often cases of excessive water level during the rainy season as well as insufficient water during the dry season causing unfavorable bird use in wetlands. Besides, excessive levels of salinity and poor water quality along with other issues are found. In order to understand the potential of water level management and water quality improvement, this study tests different water gate operation strategies. Together with surveys of water level and salinity, the suggested water gate operation plan is proposed, which may help facilitate future management of Qigu Salt Pan Wetland.

Key Words: wetland, water level management, salinity, water gate operation

生態監測為基礎的環境教育-以華江溼地守護聯盟為例

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摘要

生態監測是指有系統的調查，利用生物對環境的反應，來評估環境的改變情形。華江溼地守護聯盟 2008 年 1 月起進行生態普查、監測，分成植物組、鳥類組、昆蟲組、兩棲組、螃蟹組、月池植物相組，依據各種生物不同特性，每季、月或每 2 週進行一次監測。

根源於真實世界和一手知識的學習，依據建構教育、探究教育模式，將生態調查、科學研究轉化成活動、遊戲。以團隊活動的方式進行，先拋出問題、透過學員從問題中提出假說、動手操作、由結果來驗證或推翻假說，讓學員動腦、動手、團隊合作完成交付的任務，最後透過成果分享報告，探討生態世界奧祕。濕地探索教育不以物種認識為目標、不以先備知識學習為導向，誘導學員如何觀察、描述、辨識物種，再從個體數量的觀念，延伸棲地環境的關係。

將生態監測的模式轉化為教育活動，設計了植物探索、螃蟹探索、昆蟲探索、陷阱探索等活動，以生態夏令營、自然探索的方式實施，對溼地功能的宣導、生態教育的深化、特殊學生的學習有著顯著成效。

關鍵詞：生態監測、濕地、監測志工、華江溼地守護聯盟。

THE ENVIRONMENTAL EDUCATION BASED ON ECOLOGICAL MONITORING - TAKING THE HUAJIANG WETLAND GUARDIAN ALLIANCE AS AN EXAMPLE.

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Abstract: Ecological monitoring refers to systematic investigations that use biological responses to the environment to assess changes in the environment. The Huajiang Wetland Guardian Alliance has conducted ecological surveys and monitoring since January 2008. It is divided into plants, birds, insects, amphibious, crabs, and moon pond flora. According to the different characteristics of various organisms, each season, month or every Monitor once every 2 weeks.

Rooted in the real world and first-hand knowledge learning, based on the construction of education, inquiry education model, ecological research, scientific research into activities, games. In the form of team activities, first throw a question, ask the hypothesis from the question, start the operation, verify or overturn the hypothesis from the result, let the students brainstorm, hands-on, teamwork to complete the task of delivery, and finally share the report through the results. Explore the mysteries of the ecological world. Wetland exploration education does not aim at species awareness, and is not guided by prior knowledge learning. It induces students to observe, describe, and identify species, and then extend the relationship between habitat environment from the concept of individual quantity.

Transforming the model of ecological monitoring into educational activities, designing activities such as plant exploration, crab exploration, insect exploration, trap exploration, etc., implemented in the way of ecological summer camp and natural exploration, the promotion of wetland functions, the deepening of ecological education, and special Students' learning has achieved remarkable results.

Key Words: Ecological monitoring, wetlands, monitoring volunteers, Huajiang Wetland Guardian Alliance

建造滯洪池與;盈地成為海綿城市之研究－以高雄市為例

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摘要

本研究以高雄市政府建造 13 個滯洪池與 21 個溼地成為海綿城市之研究進行 SPSS 統計軟體的典型相關分析，以評估不同項目單元對於氣候變遷下的防洪管理，蒐集資料期間為 2018 年 8~9 月。因此，本研究引用官方數據以西元 1984~2017 年總雨量(P)，建造滯洪池及濕地面積公頃(DPW)為雨量、面積項目單元，編製滯洪池蓄水量大小不同等級，使用濕地的官方國家型、地方型、其他型分級(G)。並且，編製流域水系大小不同等級，使用濕地的官方海岸型及內陸型分級(GOL)，皆為等級項目單元。分析結果顯示雨量、面積項目單元與等級項目單元二者典型關係數平方為 0.229，loading 值 P 為-0.045，DPW 為 0.938 顯著性，G 為-0.999，GOL 為 0.366 顯著性。雨量、面積項目單元自我相關數值為 44.079%，RI 數值為 12.945%。等級項目單元自我相關數值為 51.588%，RI 數值為 10.084%。

關鍵詞：滯洪池、濕地、海綿城市、防洪效益、氣候變遷

STUDY ON THE CONSTRUCTION OF THE DETENTION PONDS AND WETLAND OF SPONGE IN KAOHSIUNG CITY

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Abstract: 1n this study, a typical correlation analysis of SPSS statistical software Canonical Correlation Analysis was applied to evaluate the effects of different project units on the rainfall of sponge cities in Kaohsiung on the climate change through constructing 13 detention ponds and 21 wetlands. The data were collected from August to September 2018. As a result, the study cited from the official data from the year 1984 to 2017, total Precipitation (P), the construction of stagnant detention ponds and wetland area of hectares of rainfall, the area of the project unit (DPW), the establishment of detention pond storage are different in size levels. While the use of wetlands is classified into national, local, and other types (G). Furthermore, the official coastal and inland type classification of the drainage system are classified as grade project units (GOL). The analysis results showed the rainfall area project unit and level project unit as the typical relationship square number is 0.229, loading value with total rainfall P is -0.045, DPW is 0.938 signs, G is -0.999, GOL is 0.366 signs. Rainfall, the area Project unit self-correlation values are 44.079%, RI values of 12.945%. The level item unit self-correlation value is 51.588%, RI value of 10.084%.

Key Words*:* detention pond, wetland, sponge city, flood management, climate change

利用草魚及吳郭魚進行生物防治外來種人厭槐葉萍的研究

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摘要

位於國立蘇澳高級海事水產職業學校(以下簡稱蘇水)內的聖湖是宜蘭縣的重要濕地。然而，近年來其湖域內卻受到外來種人厭槐葉蘋嚴重入侵而導致整個湖面都被其覆蓋且濕地有陸化的徵象。因此，本論文主要使用草魚及吳郭魚進行生物防治人厭槐葉蘋的可行性研究。本研究的試驗主要在蘇水內操作，試驗一探討不同魚體大小(大草魚組及小草魚組)對於移除人厭槐葉蘋(攝食量)的差異。結果顯示大草魚組有較多的攝食量，且其活存率顯著高於小草魚組。試驗二探討人厭槐葉蘋的新鮮度(定期更換或定期補充)是否會影響草魚的攝食量，結果顯示兩組並無顯著差異。試驗三探討草魚與其他水生生物(吳郭魚)對人厭槐葉蘋生物防治的效益，結果顯示以草食性為主的草魚明顯優於雜食性的吳郭魚。綜合以上的試驗結果，建議在類似的濕地環境裡，宜選擇大小適中的草魚進行外來種人厭槐葉蘋的生物防治。

關鍵詞：濕地、生物防治、人厭槐葉蘋、草魚、吳郭魚

USING GRASS CARP(CTENOPHARYNGODON IDELLA) AND TILAPIA FOR BIOLOGICAL CONTROL OF INVASIVE WATERMOSS (SALVINIA MOLESTA)

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Abstract: Lake Shenghu is located in National Su'ao Maritime & Fisheries Vocational High School, one of the important wetlands in Yilan County. However, the lake is not only being seriously invaded and covered by watermoss (Salvinia molesta) but also being through the habitat alternation in recent years. Therefore, the study mainly explores the possibility by using grass carp and tilapia for biological control on Salvinia molesta.

The study including three trials was conducted in National Suao Maritime & Fisheries Vocational High School. Trial 1 investigated the food intake of the two fish sizes (bigger grass carp and smaller grass carp). The result showed the bigger grass carp having more food intake and higher survival rate than that of the smaller ones. Trial 2 explored whether if the freshness (regularly new replacement or regular complementary) of Salvinia molesta will affect the food intake preferences of grass carp. The result showed no significant differences between the two groups of freshness. Trial 3 examined the differences of food intake between the omnivorous and herbivorous fish i.e. tilapia and grass carp, of which the latter performed better than that of the former. Based on the overall investigations above, it can be suggested to apply the suitable size of grass carp for the biological control on Salvinia molesta under similar wetland conditions.

Key Words: wetland, biological control, Salvinia molesta, grass carp, tilapia

濕地藝術環境行動對志工環境教育之成效評估：以新北濕地藝術季為例

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摘要

2004 年起，新北市政府開始構築「現地處理水質淨化系統」，6 年間陸續完成大漢溪沿岸 8 座人工濕地，並於 2010 年開始推動濕地環境教育，於 2017 年首次導入濕地環境藝術行動。本研究針對「2018 新北濕地藝術季」的濕地環境藝術作為研究核心，其中參與者包含兩位藝術家、藝術志工、環境教育志工，並透過開幕音樂會、現地展覽、市集等方式向大眾推動濕地環境意涵。

本研究以參與新北濕地藝術季之志工為主要研究對象，探究受訪志工環境態度與地方依附之關係，並討論濕地藝術季中有哪些關鍵性因素，能提升志工的環境教育理念。首先藉由量表之敘述性統計、多元迴歸分析實證結果得知，環境態度正向顯著影響地方依附，換言之，受訪志工對環境的態度越正向，地方依附的程度亦顯著增加。其次以瞭解志工在藝術季過程中對於環境教育的情意與理念之改變，研究方法採取質性研究取徑，透過深入訪談蒐集資訊，並採用 Argyris, Putnam 與 Smith (1985)所提推論階梯的概念來分析資料。研究結果顯示，本藝術季能提升志工對環境教育的理念與態度，並持續對濕地有情感上涉入與認同，且能有效地提升志工對環境教育的責任感。

由上述可知，建立志工參與環境藝術教育，才能提高環境教育之價值，達到永續發展之目標，並以人與濕地共生，才能生生不息的理念，打造都市濕地的友善環境空間。

關鍵詞：環境態度、地方依附、環境行動、環境教育、新北濕地藝術季

EVALUATION OF VOLUNTEER ENVIRONMENTAL EDUCATION FOR WETLAND ART ENVIRONMENTAL ACTION : A CASE STUDY OF THE NEW TAIPEI WETLAND ART FESTIVAL

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Abstract: In 2004, New Taipei City Government began to construct a "on-site treatment water purification system". Wetlands along the Dahan River were completed after six years of constructions. Wetland environmental education was promoted in 2010, and wetland environmental art was introduce to the first time in 2017. New Taipei Wetland Art Festival was held in 2018. Participants of the festival include two artists, artistic volunteers and environmental education volunteers. The wetland environmental implication was promote to the public through opening concerts, on-site exhibitions and fairs.

This study focused on volunteers who participated in the New Taipei Wetland Art Festival 2018. And discussed the environmental action key factors in the Wetland Art Festival, which enhance volunteers' cognition of environmental friendly concept. First, the research design of the study adopted qualitative approach. In order to understand the changes of volunteers' feelings and ideas about environmental education during the art festival, art-related environmental friendly behavior were surveyed. The Ladder of Inference developed by Argyris, Putnam, and Smith (1985) was used to analyze data. Second, In addition to explored the relationship between volunteers' environmental attitude and place attachment, used the Likert scale.

Based on the research findings: 1. indicated that the art festival can improve volunteers' environmental attitude, increase volunteers' place identification and emotional involvement for the wetland, and promote environmental responsibility; 2. descriptive statistics and regression analysis show that environmental attitudes can positively and significantly affect place attachment.

Finally, establishing volunteers to participate in environmental art education can increase the value of environmental education and achieve the goal of sustainable development.

Key Words: environmental attitude, place attachment, environmental action, environmental education, New Taipei Wetland Art Festival.

基隆河社子島濕地四斑細蟌生態調查及志工調查基地建置

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摘要

本文探討 2018 年荒野保護協會於社子島濕地基隆河岸發現四斑細蟌後，志工協助進行四斑細蟌生態調查及建置調查基地之過程及成果。四斑細蟌為 IUCN 列為近危物種，2005 年在台灣首次發現後，目前僅分布於淡水河流域下游之五股濕地及基隆河磺港溪口濕地，亟需瞭解其棲地特性及積極保育。2018 年荒野保護協會於社子島濕地舊堤外之基隆河岸濕地發現四斑細蟌，故召集志工進行生態調查。荒野志工發現該濕地若密集調查，調查人員踩踏可能造成棲地干擾，因此以竹子及回收棧板等簡易材料搭建架高於地表之調查基地，以及設置簡易水尺。2018 年 5 月至 6 月間，於調查基地進行四斑細蟌稚蟲、成蟲、水位及水質調查，已完成小潮、中潮及大潮等不同潮汐之調查，共計完成 6 次全潮週期調查。經過初步探討基隆河水位與該處棲地水位變化關係，以及觀察棲地之漲退潮水流流向，已瞭解該棲地之靠基隆河側地表較高，靠堤防側之地表較低，形成類似周圍高、中央低的地表型態，也是適合四斑細蟌之棲地環境。另探討該處棲地之風力、氣溫、水深、水位、水質與四斑細蟌稚蟲成蟲數量之關係，已初步瞭解該處棲地之環境特性。荒野保護協會志工於社子島濕地基隆河岸進行四斑細蟌生態調查之成功經驗，可作為其他濕地之公民科學家推動之典型案例。

關鍵詞：社子島濕地、四斑細蟌、志工、調查基地、公民科學家

THE ECOLOGICAL SURVEY AND VOLUNTEER SURVEY BASE ESTABLISHMENT FOR MORTONAGRION HIROSEI IN SHEZI ISLAND WETLAND OF KEELUNG RIVER

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Abstract: This study explored the investigation process and result that after The Society of Wilderness (SOW) has found the *Mortonagrion Hirosei* in Shezi Island Wetland of Keelung River in 2018. Since then, volunteers have helped implement *Mortonagrion Hirosei* ecological survey and establish a survey base. *Mortonagrion Hirosei* is listed as a near-threatened species by IUCN, and they were found in Taiwan in 2005, currently only distributed in WuKu Wetland in the downstream of Danshui River Basin and Hung-Kang Creek Mouth wetland in Keelung River, and it was necessary to understand the habitat characteristics. In 2018, SOW found *Mortonagrion Hirosei* in Shezi Island Wetland of Keelung River, so volunteers were called to start ecological surveys. SOW volunteers found that under intense survey, the habitat in this wetland would be interfered by the footsteps of people who do surveys, so bamboo and recycled pallets were used to make a raised base, so did a simple water gauge. Between May and June in 2018, surveys of *Mortonagrion Hirosei* a larva and imago, water level and water quality were done at the survey base, and surveys of tide changes and spring tide were completed, in a total of six full tide cycle surveys. Through preliminary discussions on the relationship between Keelung River water level and habitat water level change in that area, and observations on the water flow of high and low tide in the habitat, it was understood that the ground at the habitat is higher toward the Keelung river side as compare to the embankment side, forming a basin type of land suitable for *Mortonagrion Hirosei*. Additional discussions on the habitat's wind, temperature, water depth, water quality and the relationship between the numbers of *Mortonagrion Hirosei* larva and imago were done, and a preliminary understanding about the habitat's environmental characteristics was obtained. SOW volunteers' successful experiences on *Mortonagrion Hirosei* ecological survey in Shezi Island Wetland of Keelung River can be a good model for other citizen scientist promotions of wetland.

Key Words: Shezi Island Wetland, *Mortonagrion hirosei*, volunteer, survey base, citizen scientist

利用水質指標與優養化探討中都濕地與愛河中都段之關係

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摘要

中都濕地於 2011 年落成，建設目的為淨化愛河水質，但是因為系統設計問題，導致水體循環不佳，造成優養化現象發生。此外，供應人工濕地的愛河水體時常發生赤潮現象，為了瞭解中都濕地及愛河水體情況，為期一年的水樣採集與分析，以便提供後續探優養化問題討及濕地水利工程改善及建議。

利用水質參數顯示中都濕地除污效能不好，以及利用水質指標評估水體具嚴重污染的結果；使用卡爾森單一指數及群落指數評估愛河及濕地優養化情況，評估結果水體呈現優養化現象；應用浮游藻類數量百分比探討族群比例，水體優勢物種為 Pseudobattonella sp.、Cyclotella sp.及 Euglena sp.。

研究發現影響浮游藻類的因子分別為鹽度、生化需氧量及浮游動物，同時也利用相似度分析法得知浮游動物的分佈，在愛河及濕地是不同的群落。

研究結果顯示中都濕地除污效能不佳，而且愛河與中都濕地的水體也確實存在優養化的問題。此外，中都濕地因水利工程設計上的不良，將導致濕地水體的水文循環不佳，因而無法發揮淨化水質的效果。因此後續在濕地水利工程上的改善建議，利用單向閘門來控制水流，以迫使濕地內水體進行單向循環，而增加其流動率，以減少營養鹽累積作用，減緩優養的情況發生。

關鍵字: 中都濕地、水質指數、生物群落指數、浮游生物、優養化

INVESTIGATION OF RELATIONSHIP BETWEEN JHONGDOU WETLAND AND LOVE RIVER JHONGDOU SECTION BASED ON WATER QUALITY INDEX AND EUTROPHICATION

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Abstract: Jhongdou artificial wetland was completed in 2011. The original purpose to build this wetland was to depurate Lover River. Due to Jhongdou wetland park was poorly designed on hydraulic engineering which made the water body unable to be circlated completely and thus caused eutrophication occurring in the wetland.

Apply water quality parameters and water quality index can be found that Jhongdou artificial wetland was poor decontamination efficiency and River body was heavily polluted. Study Carlson single index and biodiversity index to assess Love River and wetland water body eutrophication. The assessing results showed that the water body was presented eutrophicaton. In additions, we also used the percentage to investigate species composition in both water bodies. It was found that the dominant species was Pseudobattonella sp., Cyclotella sp. and Euglena sp.

In the study, salinity, BOD5 and zooplankton were influence phytoplankton growth up. Meanwhile, we used the method of similarity analysis phytoplankton groups was different in Lover River and wetland.

The results showed that Jhongdou artificial wetland there was decontamination of poor performance, which made both Love River and Jhongdou wetland indeed had the problem of eutrophicatio. Beside, due to a poor hydraulic engineering design Jhongdou wetland, the circulation of wetland water was poor, resulting in less function in water purification in the wetland. we suggested to use one-way gates to control the water flow into the wetland from Love River, which could force the wetland water to conduct one-way loop, and enhance the water turnover rate, nutrients accumulation was reduced and the eutrophication problems was solved.

Key Words: Jhongdou wetland, Rivers pollution index, Diversity index, Plankton, Eutrophication.

應用歷史圖資與能值生態系健康指標探討生態系管理與復育目標－以雙連埤濕地為例

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摘要

本研究根據能值系統理論，提出以能值方法之生態系健康指標，並以雙連埤濕地劣化的過程為例，探討其指標變遷。首先蒐集雙連埤之歷史圖資，依系統變遷的概念，將雙連埤劣化過程分為四個時期：原始時期、水田時期、旱田時期與工程後時期。再分別繪製各時期系統圖，蒐集各時期的資料，並以長、短程通用筒模式模擬各時期的溼地水文情境狀態。結果表示，如假設原始時期為生態系最健康狀態，其指標為 100%，水田時期與旱田時期同為 88.35%，工程後時期則是劣化最為嚴重的時期，能值生態系健康指標為 79.78%。

能值生態系健康指標主要是以驅動力之角度檢視生態系的狀態，當驅動力改變，生態系演替發展將朝向另一方向。在進行生態系管理與復育時，建議先由能值生態系健康指標評估其狀態，以掌握可以恢復的程度。

關鍵詞：生態系健康指標、能值系統、系統變遷

ESTABLISHMENT OF ECOSYSTEM HEALTH INDICES USING EMERGY ANALYSIS AND HISTORICAL GEODATA - A CASE STUDY OF SHUANGLIANPI WETLAND, NORTHEASTERN TAIWAN

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Abstract: Emergy-based ecosystem health indices were applied to evaluate the degraded process of Shuanglianpi wetland in the northeastern Taiwan. First, the historical maps and aerial photographs were collected. The degradation process was classified as four stages based on the system transition theory and the historical data, the original stage, the paddy stage, the dry farmland stage, and the post-construction stage. The system diagrams of the four stages were drawn and the emergy of the four stages were also evaluated. The Long and short terms runoff model (LST) was employed to simulate the hydrology of each stage. As the result, if the original stage was assumed the most health stage and its ecosystem health degree is assumed 100% as the baseline, then those of the Paddy and dry farmland stages were both 88.35%, and that of the post-construction stage period is 79.78%.

The emergy-based ecosystem health indicators examine ecosystem's state from the viewpoints of the driving forces of a system. The trajectory of ecosystem development will turn into a different direction if the driving forces are changed. The emergy-based ecosystem health indicators can also reveal the potential of the restoration.

Key Words: ecosystem health indicator, emergy system, system transition

雙連埤濕地植物復育之水文地形規劃

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摘要

台灣東北部之雙連埤濕地曾有豐富的水生植物，但於 2003 年正式公告為保護區前之疏濬並導致許多水生植物的逐漸消失與自然恢復的障礙。 未擾動前的植物恢復需要先恢復適合植物恢復的水文地形，而當時並未調查這些資料。因此，本研究之目的為探討適合濕地植物復育之水文地形規劃。 首先調查現在的植物分佈、地形與水位紀錄等。再應用歷史植物調查文獻與航空照片繪製可能的植物復育分區，並與現況植物與水文地形比較，以辨識造成植物恢復困難的可能因素。最後，根據每一復育分區的優勢植物與重要植物之水文屬性，以及應用環境篩選模式之概念，推估出每一植物復育分區之可行的水文地形。

關鍵詞: 溼地植物復育、環境篩選模式、水文屬性、水文地形

HYDROGEOMORPHIC PLANNING FOR THE WETLAND VEGETATION RESTORATION IN THE SHUANGLIANPI WETLAND, NORTHEASTERN TAIWAN

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Abstrat: The Shuanglianpi wetland in northeastern Taiwan was inhabited abundant wetland vegetation species, but dredged due to dredging and diking in 2002, a year prior to the formal declaration of the wetland as a protected area. It resulted in the vanishing of various wetland vegetation and a barrier to recover naturally. The restoration of early vegetation species requires the restoration of a proper hydro-geomorphology in advance. However, the previous hydro-geomorphology were not surveyed and thus unavailable. Therefore, the purpose of this research was to make a feasible plan of the hydro-geomorphology of wetland for the Shunglianpi wetland vegetation restoration. The current vegetation distribution, wetland geomorphology, and water table records were first investigated. Then, the historical wetland vegetation investigation documents and aerial photographs were applied to plan a map of potential recovered vegetation zones, and to compare with the investigation of current wetland vegetation and hydro-geomorphologic environments for identifying the possible causes in vegetation recovering difficulties. Finally, a feasible hydro-geomorphologic plan of each zone was approximately estimated according to the hydrological attributes and the concept model of environmental sieves of the historical dominated or important species.

Key Words: wetland vegetation restoration, environmental sieve model, hydrological attributes, hydro-geomorphology.

tree shelters 微地形直播方法增進木賊葉木麻黃幼苗出現

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摘要

臺灣於 1897 年引進木賊葉木麻黃於海岸地區造林，並成為海岸林相當重要及主要的造林樹種,但因生育地逆壓環境、長期缺乏管理、病蟲危害及颱風災害，導致木麻黃生長勢逐漸衰退及枯死，使林地產生孔隙，為了維護海岸林之整體保安功能，海岸林孔隙需持續造林。直播造林的優點在於操作簡單、造林成本低、直播苗根系完整及適應力佳。因此，本文目的為發展木麻黃於海岸林直播造林方法。試驗結果顯示運用 tree shelters 微地形直播方法，8 個月的生長期間播種點的幼苗發生率為 97%,幼苗存活率為 88%,幼苗建立率為 86%,以及樹高為 31±2 cm。運用此法可成功培育木麻黃幼苗及提高生殖性狀，提供特定海岸地區發展具有地域特色的直播造林作業方法及實施潛力。

關鍵詞：木麻黃、凹地、直播、tree shelters

APPLYING TREE SHELTRS AND INDENTATIONS INCREASING THE SEEDLING EMERGENCE OF *CASUARINA EQUISETIFOLIA*

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Abstract: *Casuarina* spp. was introduced into Taiwan in 1897 for plantation in coastal areas, and it had become an important and main windbreak species. Due to environmental stresses, diseases, poor tending and typhoon disasters, these trees often degenerated and died, which result in gaps in stands. In order to maintain the functions of coastal forests, the gaps of coastal stands have been reforested repeatedly. Advantages of direct seeding compared with planting are that it is simple in practice, low in cost, and has intact root systems and good adaptability. Therefore, the purpose of this study is to develop a technique of direct seeding of *C. equisetifolia* for coastal plantation. The study showed that seedling emergence of sowing spot was 97%; seedling survival was 88%; seedling establishment was 86% and height was 31±2 cm at 8 months of seedlings with direct seeding of indentations using tree shelters. By using this method, *C. equisetifolia* seedlings can be successfully cultivated and their reproductive traits was improved. This direct seeding method can be applied in specific coastal areas in Taiwan.

Key Words: *Casuanina*, indentation, direct seeding, tree shelter

應用多尺度方法評估雙連埤濕地植物復育之可行性

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摘要

雙連埤濕地曾有豐富的水生植物，但於 2003 年正式公告為保護區前之疏濬並導致許多水生植物的逐漸消失與自然恢復的障礙。本研究以三種尺度方法，評估雙連埤濕地植物復育的可行性，分別為現地大尺度植物與水文地形調查、中尺度復育試驗與小尺度種子庫發芽試驗。

現地大尺度評估進行水位監測，並調查岸邊8條樣線上之植物、土壤及坡度。中尺度復育試驗區則是在濕地南區一突出部兩側進行岸區地形調整，一區移植所欲復育的植物 16 種；另一區則未移植植物，隨其自然恢復。中尺度復育試驗區，共設置 10 條樣線，於樣線上調查植物、土壤與坡度。小尺度種子庫試驗則於大尺度與中尺度所調查的樣線與濕地中間處取土壤樣本，於實驗室進行淹水與土壤濕潤兩種情境下之種子發芽試驗。

結果顯示，現地大尺度評估上，水位變動落差不大，岸邊坡度在平均水位線附近過陡，故現存植物物種之水文屬性多為暫時性淹水與飽和。中尺度復育試驗則顯示移植植物區之物種數與多樣性較高。種子庫試驗結果共計 44 個物種發芽，濕潤環境處理的發芽物種高於淹水處理。以取樣地點而言，顯示現地埤岸具有較高密度的土壤種子庫。比較土壤種子庫與現地植被的物種組成，發現相似度約為 25.0%，顯示目前現地優勢物種非以種子庫繁殖為主。比較早期調查資料，顯示現況植被較缺乏種子庫物種、一年生物種、以及水文屬性為永久、半永久與暫時性淹水之物種。評估結果顯示現況不利於植物自然恢復。未來復育需要調整水文地形，使棲地適合各種水文屬性的植物物種生存，同時需要引入種子庫物種。

關鍵詞：環境篩選模式、水文屬性、土壤種子庫、濕地植物復育

APPLICATION OF MULTI-SCALE METHODS TO EVALUATE THE FEASIBILITY OF WETLAND VEGETATION RESTORATION IN SHUANGLIANPI WETLAND, NORTHEASTERN TAIWAN

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Abstract: The Shuanglian Wetland was once rich in aquatic plants, but the dredging and diking by the former owner led to the gradual disappearance of many aquatic plant species and obstacles to natural restoration. In this research, the feasibility of natural restoration of vegetation in Shuanglian Wetland was evaluated by three-scale methods, namely, *in-situ* macroscale evaluation by vegetation and hydrological topographic survey, mesoscale restoration experiments and microscale seed bank germination experiment.

Wetland water level monitoring and field investigation of plants, soil and slope on 8 transect lines on the shore was conducted for the *in-situ* macroscale evaluation. For the mesoscale vegetation re experiment, the topographical terrain on both sides of a prominent part of the southern part of the wetland was adjusted. Then, 16 plants were to be replanted in one area, where none of any plants was transplanted to let plants naturally recover in the other area. In the mesoscale restoration experiments, vegetation, soil, and slopes along 10 transect lines were investigated. In the microscale seed bank experiment, the germinated seeds in the soil samples from the 8 and 10 transect lines in the macroscale and mesoscale surveys were examined in the laboratory under the two different treatment of the soil moisture at water-logging or moist conditions.

The large-scale assessment indicated that the water level fluctuation is not significant and the slope on shore around the near the average water level is too steep. Therefore, the hydrological attributes of existing plant species are mostly “temporary flooding” or “saturation”. It displayed higher numbers and diversity of species in the transplanted plant area in the mesoscale experiments. A total of 44 species were germinated in the microscale seed bank experiments, and the germinated species treated in the moist environment were higher than the water-logging treatment. In terms of sampling locations, it shows a high density of soil seed banks on the shore than inside the wetland. Comparing the species composition of the soil seed bank with the existing vegetation, the similarity was found to be about 25.0%, indicating that the current dominant species are not dominated by seed bank reproduction. Comparing the earlier survey data, the seed-bank species and the species with the hydrological attributes of permanent, semi-permanent and temporary flooding were less founded. The evaluation results show that the current wetland condition is not ideal for the natural restoration of vegetation. Several tasks are required for the natural restoration including the restoration of hydro-geomorphology, the re-design of water outlet for more significant water level fluctuation, and re-introduce seed bank species.

Keywords: environmental sieve model, hydrological attributes, soil seed bank, wetland vegetation, restoration, restoration

因應氣候變遷下之公園綠地系統規劃設計-以臺北市社子島地區為例

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摘要

近幾年來「永續」、「生態」、「景觀」、「綠色基盤」、「與水共生」等是當代都市、建築與景觀專業領域朗朗上口、耳熟能詳的關鍵字，這代表著觀念上、知識上、設計手法及技術支撐上的轉變。

本研究以臺北市社子島地區為規劃範疇，為因應日益嚴峻的全球環境變遷及資源枯竭的衝擊，透過生態城市規劃之理念與方式，朝尊重生態、強化防災滯洪、節能減碳、重視人本等思維進行濕地地景公園規劃設計，期加速轉型，有效因應未來地球暖化問題，達到形塑整體都市意象，以提高生活環境品質。

社子島地區位於感潮帶(基隆河與淡水河匯流處)，且西北方有關渡重要濕地(含關渡自然保留區及關渡自然公園)，西南側則有五股人工重要濕地緊鄰，吸引大批候鳥棲息覓食，為重要的候鳥棲息地，使社子島環繞於豐富的濕地及自然生態當中。是故本案在社子島開發計畫的基礎下，同時考量環境影響評估對於生態、景觀、水文水質的要求，將中央生態公園以低衝擊開發1(LID)之規劃方式，於 42 公頃的中央生態公園中設置約十公頃的景觀河道，以良性之生態嵌塊體來加強其生態多樣性，並結合生態廊道、跳島功能，型塑生態棲地，透過藍綠帶廊道加強串接空間連續性，藉由不同類型之生態棲地的營造及界定各公園綠地開放空間之功能，發展具有生態親水、生態休閒活動之區域，並強化未來因應可能發生之強降雨及其他災害的應變能力，配合風險溝通與適度的工程改善，以提高災害治理效率，增強社子島因應災害衝擊的調適能力，減緩颱風洪氾期間之暴雨或洪水對居住環境衝擊，促進生態城市的營造，實現人與自然和諧的最佳化關係，實踐生態水綠環境之開發理念。

關鍵詞：濕地生態棲地、環境調適、低衝擊開發、公園規劃

[1]低衝擊開發(LID)具有「減低暴雨逕流」、「淨化水質」與「以提升生態效益及景觀功能為周邊效益」等功能。

PLANNING AND DESIGN OF PARK AND GREEN SPACE SYSTEM TO CLIMATE CHANGE - THE CASE STUDY OF SHEZIDAO IN TAIPEI CITY

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ABSTRACT

"Sustainable and Ecological Landscape", "Green Infrastructure", and "Living with Water" are the keywords mentioned in the field of architecture, landscape architecture, and urban planning in recent years. It means that concept, knowledge, design method, and eco-technology are changed into more permaculture design's approach.

This research focused on Shezidao area in Taipei City. In response to solve the dramatic impacts of climate changes, urban planning and design for ecological formation are used in Shezidao. We should plan and design the wetland park associated with the concept of ecology, flood protection, energy conservation, and humanity-oriented-friendly transportation. Then we hope this design will be solved global warming issues, built the new urban image, and promoted the qualities of life from citizens.

Shezidao is located in the estuary of Keelung River and Danshui River, which is surrounded by plentiful wetlands, i.e., the Guandu Wetland in a northwestward direction and the Wugu Wetland in a southwestward direction. There is also designated as an Important Bird Areas (IBA) to be leading from her rich and natural ecosystems. The central ecological park will be planned in Low-Impact Development (LID) considering the requirements of environmental impact assessment for ecological, landscaping, and hydrological balances, and followed by the development plan of Shezidao at the same time. Approximately 10-hectare ecological waterfront will be set up in the 42-hectare central ecological park.

The habitat patches are created to increase the biodiversity and create several ecological corridors and stepping stones. We strengthen space continuity by their connection of waters and green spaces. To develop ecological water areas and leisure activities areas, we create different types of habitats and define the function of each open space in this park. Therefore, our design will be strengthened the capabilities to cope with torrential rains and other disasters in the future, cooperate with risk communication and appropriate engineering improvement to promote disaster management efficiency. Therefore, we have also enhanced the adaptability of Shezidao in response to disaster mitigation of torrential rain or flood during typhoon. We have promoted this created values of ecological city, realized the optimal relationship between humans and nature, and taken a sincere practice toward a development concept of eco-hydrological and greenery environment.

Key words: wetland habitat, environmental mitigation, Low Impact Development, park planning

利用微體古生物學和今生物學方法評估香港濕地底棲無脊椎生物

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摘要

人類所造成之環境污染、外來物種入侵以及氣候變遷等現象以複雜的機制造成濕地帶來深重影響。香港的「基圍」是傳統上在濕地環境中的漁業作業模式，這項技術在香港已有數十年以上的歷史，具重要歷史及文化意義，而使用「基圍」技術捕蝦更是一個能夠維護自然環境平衡的永續經營方法。「基圍」之建設為許多包含蝦蟹之無脊椎動物或脊椎動物營造穩定多元的棲地，是複雜食物網的重要根基，維護著濕地環境的生物多樣性；其中又以底棲無脊椎動物作為支持整個系統的關鍵物種。隨然如此，基圍生態環境相關的研究至今仍寥寥無幾，然而，不論是不同人為影響的協同效應，還是單一影響的作用，都是相當值得深入探討的議題。另外值得關注的是，部分底棲無脊椎動物——如福壽螺（Pomocea canaliculata）等——經調查後發現實為入侵外來種 ，其龐大數量與廣泛分布已為濕地生態帶來重大威脅。

本研究藉由古今生物學方法，研究甲殼亞門介形綱以及原生生物界孔蟲門之生物於米埔自然保護區之基圍中的時空分佈，期望能藉此釐清影響著底棲無脊椎動物之物種多樣性的因素 。初步研究發現在受福壽螺入侵的基圍中，孔蟲門的物種多樣性較低；在本文中我們將介紹初步之研究成果。

關鍵字：濕地生物多樣性、底棲無脊椎動物、基圍、環境變化、 微體古生物學

EVALUATION OF THREATS FACED BY BENTHIC INVERTEBRATES IN HONG KONG WETLAND USING MICROPALEONTOLOGICAL AND NEONTOLOGICAL APPROACH

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Abstract: Anthropogenic impacts ranging from pollution, introduction of invasive species and human induced climate change have been synergistically impacting wetland ecosystems in complex ways. In Hong Kong, Gei wai is one of the major wetland management strategies used for decades which has both cultural significance, and environmental benefits. Used for rearing shrimps as a fishery, the gei wai's create stable habitats with diverse characteristics suitable for the shrimp and many invertebrate and vertebrate species – creating the foundation for complex food chains benefiting higher feeding guilds, and enhancing overall biodiversity. Benthic invertebrates are the major taxa supporting the wetland ecosystem. Yet, the ecology in gei wai has been under-studied whether from the synergistic effects of multiple stressors, or from emerging individual threats. In addition, some of the benthic invertebrates such as Golden Apple Snails (Pomocea canaliculata) are found to be invasive alien species, posing threats to the wetland ecosystem as they are widespread, and abundant.

In our study, we have adopted neontological and paleoecological approaches to study the spatio-temporal patterns of ostracods (Crustacea) and foraminiferas (Protista) in the gei wais in Mai Po Nature Reserve, aiming to elucidate the controlling factors of benthic invertebrates' species diversity. In our preliminary study, we have observed a lower species diversity of foraminifera in gei wai infested by Golden Apple Snails. We will present our preliminary results in this paper.

Keywords: wetland biodiversity, benthic invertebrates, gei wai, environmental change, micropaleontology

Memo

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