

• Overview •

Attracting and recovery technology and its applications seabird populations

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Summary: Most of seabird populations in the world's threatened status. In response to this situation, According to ornithologists breeding habits of seabirds, seabird restoration techniques by means of artificial attract population and construction of suitable habitat. Attracting birds technologies include community to attract fledgling technology and transfer technology into two categories. Community attracting technology is the use of false models and sound playback attract birds near the habitat of seabirds come to method selection and transformation within the human habitat; chicks transfer is to restore populations of nestlings transferred to the reformed habitat in the ground, The growing use of seabirds dependent manner, In the breeding season to promote their return to active breeding habitat. Both of these methods have been around the world 16 Countries and regions 64 Species of seabirds, a total of 171 Attract more project has been applied. In specific applications, it should be adapted to local conditions, select the appropriate method for different types of seabirds and breeding habits, It may be used singly or in combination. We should fully carry out Regardless of the method of preliminary studies, Select and create a suitable breeding habitat, Strict control of predators, close monitoring, and remove threats, Ensure reproductive success. China's coastal breeding seabirds are facing multiple threats, Reduce seabird populations and habitat loss is serious, Application of artificial attract seabirds along the coast brings hope for the breeding seabird populations and their habitats in our recovery.

Key words: Seabirds; Breeding habitat; population recovery; Community attracting technology; nestling transfer

A review of the use of active seabird restoration techniques

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Abstract: Most seabird species are threatened or endangered To restore their populations and breeding habitats, ornithologists have developed two major active seabird restoration techniques:.. Social attraction and chick translocation With social attraction, decoys and acoustic vocalization playback are used to lure breeding seabirds to the restoration site. in chick translocation, the chicks of focal species are translocated and reared at the restoration site with the goal that they will return and breed at the release site. We conducted a worldwide search and found 171 projects conducted in 16 countries / regions to restore 64 seabird species. These techniques are used either independently or in combination, depending on the breeding biology of the target species. For both methods, managers are encouraged to understand the species' breeding ecology and preferred nesting habitat. Habitat management, predator control and close monitoring are key steps to assure the success of the restoration. The breeding seabirds of China's coast face many threats and their populations and habitats have decreased rapidly in recent decades. Active seabird restoration techniques can help to expand ranges and provide resilience to threats by starting new nesting colonies along the coast of China.

Key words: seabird; breeding habitat; population restoration; social attraction; chick translocation

1 introduction

Birds can be a generic term foraging in salt water (Schreiber & Burger,

2001) . More types of seabirds, Morphological and behavioral diversity. General seabirds
Seabirds, also known as marine birds, For those who adapt to the marine environment,

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Longer life expectancy, Reproduction late, Small nest egg counts; Most have a habit of nesting cluster, The number of individuals in the cluster as little more than a dozen, as many as the number of one million; Many migratory birds with long habits; portion ocean species, In addition to the breeding season, Most of the time off the coast of activities (Gaston, 2004) . Seabirds defined groups is not very clear. On the narrow, Seabirds including penguins and procellariiformes all mesh type, Pelecaniformes all species except the snake pelican, And Charadriiformes Branch of skuas, gulls Branch, terns Branch, shearwater families and Guillemot birds. generally, Seabirds sometimes including some species of marine environment habitat grebe Branch, Division loons, Phalarope Branch, herons, ibis and ducks in Section (Gaston, 2004) . Most ornithologists accepted seabird narrow definition. According to the traditional classification system of birds, The inclusion of the world's total seabird taxa 4 Eye 14 Family 78 Belong 335 Species (Schreiber & Burger, 2001) .

Due to the reduction of human activities caused by food, environmental pollution, bycatch in fishing nets, pick up fresh eggs and chicks capture, introduction of alien species and habitat damage and other reasons, Global close 1/3 The endangered seabird populations (IUCN, 2009) . Wherein the distribution of narrow range, due to global climate change and ocean acidification caused by habitat area is reduced, the situation threatened seabird populations decline in the quality of particularly serious (Croxall et al, 2002; Frederiksen et al, 2004) . Ornithologists seabird populations proposed recovery plan to protect threatened seabirds. Seabird populations recovery plan through human intervention measures to improve the quality of seabird habitat (Kress, 1998) . The importance of seabird populations to recover not only the protection of species and the number of seabirds, More importantly, the recovery of marine ecosystems, promote ecological processes, So seabird habitat, nutrient cycling marine and terrestrial ecosystem unity, To create a more suitable living environment (symbiotic species Jones & Kress, 2012) . Successful restoration projects seabird populations can expand the scope of the survival of threatened populations and restore their populations, Especially those populations affected by human activities and predation are threatened with extinction (Jones et al, 2011) .

Currently, Seabird breeding populations of seabirds for recovery basically restore habitat and breeding populations, There are two main ways: First, to restore the natural way (passive seabird restoration), That focus on creating and restoring seabirds have suitable habitat, Eliminate threats to seabirds breeding on the island, Including mammals artificially introduced, especially rodents and other exotic pests have a serious threat to seabirds breeding, Stop tourism, production and other human activities, Trim to fit the seabirds breeding habitat, etc., Wait seabirds choose to return to the original breeding grounds and habitat through natural diffusion. Another approach is to attract artificial recovery (active seabird restoration), I.e. habitat restoration based on suitability, Supplemented by artificial means to attract seabirds come to inhabit.

Natural recovery methods very long time span, often from the project start to bear fruit need ten years or even decades. Such a project cycle is to implement party is a great challenge, one needs to do long-term monitoring, on the other hand, In the last ten years and several decades of waiting in the process, After finishing the elimination of predators and habitat changes may also occur, Still need long-term maintenance and monitoring (Nogales et al, 2004; Donlan & Wilcox, 2007; Howald et al, 2007) . Greater difficulty lies, This requires long-term investment can hardly be effective but difficult to win the support of project funding. Thus in the world, While scientists attempt to restore natural populations of seabirds, but the real implementation of the very few (Jones et al, 2011) . Attracting and method of the project due to the relatively short period, and the effect is obvious, but at the same time in the recovery of the population, Also further promote the maintenance and restoration of habitats. therefore, This approach around the world has been widely used. For these reasons, This paper introduces for Attracting and recovery technology and its applications seabird populations.

Attracting and seabird populations began to try to recover 20 century 70 Years in the US Gulf of Maine Atlantic Puffin (*Fratercula arctica*) Reintroduced populations. The original purpose of the project is to restore those populations due to human development or invasive species disappear (Kress, 1998), Ichthyornis then applied to address the conflict, habitat damage and need to be migrated Tern breeding population (Hasegawa & Watkinson, 1982; Roby et al, 2002; Parker et al, 2007) . The method and has been widely used in the world, is an important way of artificial marine bird populations to recover.

In recent years, Since Zhejiang Nirayama Islands for the critically endangered bird Chinese crested tern (*Thalasseus bernsteini*) Attracting success of the project (Chen Shui Hua and Fan Zhongyong, 2013), Sanya attract seagulls and implementation of the project, Attracting birds and application of technology has attracted wide attention (http://www.sanyarb.com.cn/content_224832.htm) . Jones with Kress (2012) Prior to seabirds worldwide Attracting and restoration projects for a more comprehensive introduction, on the basis of this, We complement the latest information through a variety of ways literature review, expert consultation, comprehensive introduction seabird populations Attracting and recovery technology and its applications for the study of seabird diversity of our country, protection and management for reference.

2 Attracting seabird populations and recovery technology

Attracting seabird populations and recovery technologies can be divided into fledgling technology transfer (chick translocation) Community and attract skilled (social attraction) (table 1) . Nestling transfer mainly for those who have a strong love at home (place of birth) tendency of seabirds, These birds generally do not need parents

table 1 Attracting seabird populations and restore the two main technical table

Table 1 Comparison between the two major techniques of active seabird restoration

	Fledgling technology transfer Chick translocation	Community attracting technology Social attraction
principle	Nestling transferred to the target islands, Artificial feeding until the flight departure. Seabirds tend to take advantage of the growth of the attachment of. These attract the chicks grow up to return to target breeding islands	Layout model bait and sound playback device on the destination island, the use of the cluster community of seabirds attracted behavior attracts seabirds to come near the breeding habitat Decoys and audio playback systems are deployed at the restoration site to attract adult colonial seabirds, which select their breeding site by using social information.
Overview	Transfer seabird nestlings to the target island, and rear them until they fledge. The released birds may return to the restoration site. This method is best for species that demonstrate strong natal site philopatry.	
Technical Points	Artificial rearing chicks and flying field	Placed fake bird's layout and sound playback device
Key techniques	Chick rearing and release	Decoys and audio playback system deployment
Scope	It has a tendency to love at home, easily in captivity, burrowing type seabirds, such as albatrosses and petrels, etc.	Clusters of strong, Parents need to nurture fledgling late seabirds such as terns and gulls, etc.
Preferred species	Species with strong natal site philopatry such as albatrosses and storm-petrels	Colonial breeding species with weak natal site philopatry such as terns and gulls
limitation	We need to invest more human and material resources for rearing chicks; Improper breeding and transportation may cause injury to chicks; The success of a relatively long period	Quick, Forming a breeding colony has a snowball effect, but apart from gulls and terns and other seabirds strong cluster of other seabirds attract success rate is relatively low
Limitations	Labor intensive and expensive because of the need for chick tending stewards; great care during transport and chick rearing to reduce mortality to chicks; may take many years to achieve restoration because most species do not breed until they are five or more years old.	Colonization around decoys and audio speakers may happen quickly as the first breeders help to advertise the location of the colony, but a relatively lower success rate for other species except for terns and gulls.
Effective period	5-10 year	1-5 year
Establishment period	5-10 years	1-5 years

Tending, It is easy to captivity. Transfer the chicks chicks need to migrate to the target islands, Artificial feeding until flight departure. These birds have a growth environment to preserve memories, It is possible to return to growth after sexual maturity, breed, Even promoting other individuals of the same species of birds come together, Attracting so as to achieve the purpose of (Miskelly & Gummer, 2013) . Nestling as it involves the transfer of artificial rearing chicks and flying field, Thus requiring greater investment of human and material resources. And generally limited to birds, fish or cud-eating, As of Albatrosses and Petrels and so on. Birds need for parents bringing up late, such as terns, nestling transfer method is inappropriate.

Community is the most important means to attract skilled ongoing restoration of seabird populations. It is mainly carried out nesting habitat to attract people through the **planning of breeding birds (Jones & Kress, 2012) . As the global 95% Above sea birds** have clustering, which means they will be attracted the same kind or other similar **ecological habits of breeding seabirds gathered (Rolland et al, 1998), Early arrival** habitat of seabirds can be used as live bait to attract more birds to come. Community suction techniques typically model bait and sound playback equipment combined **model used for diurnal seabirds, The sound of diurnal and nocturnal birds have attraction (Jones & Kress, 2012) .**

Community attracting technology used widely, The main characteristic is the use of a cluster of seabirds (Rolland et al, 1998), Before the arrival of their breeding season, Choose a suitable island, Artificial breeding seabirds transformed into suitable habitat, Birds use of false, fake eggs, artificial caves and sea

Birds breeding seabirds sound playback attracted to this breed. This technology is the **Audubon Society of the United States (National Audubon Society) of Stephen Kress Dr. propose, And first applied to the Gulf of Maine attract common tern (*Sterna hirundo*) And Arctic tern (*S. paradisaea*) The project on (Jones & Kress, 2012) .**

Specific steps and methods attract art community as follows:

(1) Choose the right island. Select the type of bird island and is planned to attract about. Recommended to choose attract habitat of the species in potential breeding areas or historical breeding areas. In the choice of the island we need to transform the environmental characteristics of habitat slope, vegetation density and height, so as to ensure that the entire breeding population can be monitored at any time. Before you begin to attract events, The island should be cleared of all species of breeding seabirds threatening, including predators snakes, rats and so on. Covert monitoring stations set up around the area attract, Continuous observation without disturb seabirds.

(2) Attract the transformation of habitat. Monitors environmental transformation matrix based on the desired seabirds breeding habitat, such as soil, rock and vegetation proportions, caves, Vegetation height. In laying the ground has been reformed fake birds habitat model, sound playback equipment, etc., to lure the nearby islands of habitat or passing seabirds. In monitoring the whole camp to see if breeding areas exist to monitor the blind spot, if present, to install video surveillance equipment in the vicinity of the blind spot monitoring, In order to fully understand the status of the entire habitat.

(3) Attract monitor and protect habitat. After the birds were lured to this breed, to maintain continuous monitoring, Stop the illegal landing and picking up eggs, etc.

Human disturbance behavior, While viewing the entire habitat and the surrounding environment if the underlying factors threatening seabirds breeding. The behavior of the entire breeding seabirds to monitor, Including nesting site selection, Courtship and mating, spawning incubation, rearing chicks behavior and interspecific competition and cooperation. Around the island to observe whether there are other seabird habitat exists and monitor its behavior to attract seabirds breeding any impact. According to the actual situation on the island at any time to clear the factors that threaten attract seabirds, including the arrest of predatory animals, birds of prey such as driving.

(4) Survey the area near habitats attract. Attract confirm whether there are other nearby habitats breeding colony, In order to attract further evaluation and analysis of results.

3 Application of seabird populations Attracting

Up 2016 Late last year, Application of seabirds Attracting national and regional technology are 16 , Involving 64 Species of seabirds, 171 Attract more projects (Table 2) . The attract seabirds covered 19.1% Seabird species, which 41% The endangered species. In these projects, 18 Projects using fledgling transfer method, 12 Projects only use fake birds, 19 One uses only sound playback, 9 Projects in conjunction with the fledgling transfer and sound playback, 3 Project combines the fledgling transfer and fake birds, 76 Projects combined with fake birds and sound playback, 9 Projects combined with sound playback and artificial caves.

In the known results attract 112 Projects, 75 Project a success. among them, Use only sound playback, transfer and fake bird chicks project, Success rates were 42% (n = 19) , 87.5% (n = 8) with 44% (n = 9) . The combination of using a variety of methods, the success rate is up to attract 80% the above (n = 56) . From the point of view of birds groups, the success rate of artificial attract different groups there are also differences. Procellariidae success of birds attract the highest proportion of 81% (n = 16), Tern Branch attract success rate 71% (n = 55), Gull Division of the 64% (n = 11), Swallow Branch 60% (n = 10), Cormorant Branch 37.5% (n = 8), ALBATROSS 33%

table 2 Seabirds artificial restoration project applications and distributed around the world

Table 2 Distribution of active seabird restoration projects worldw ide

country / region Country / region	Items Number of projects
Canada Canada	6
United States United States	91
Mexico Mexico	twenty four
Ecuador Ecuador	1
Bermuda Bermuda	3
The British Virgin Islands British Virgin Islands	3
Scotland Scotland	1
Ireland Ireland	4

(N = 3) .

4 Typical Case

4.1 Maine Atlantic Puffin and attract terns of work

in history, Located in the northeastern United States Maine Eastern Egg Rock Atlantic Puffin Island is the breeding habitat of the island once, but 19 After the end of the century they disappeared from the island (Kress, 1997) .

1973 year Stephen Kress Dr. chose the island as a place to attract the puffin, They can be expected to return to the island breeding habitat. They first moved to the juvenile puffins Eastern Egg Rock

The island breeding, We hope they can return to the island sexually mature breeding. 12 In between, they were transferred 954 Chicks, which 940

Leave the nest after only breeding success. 4 Years later, when the rearing of Atlantic Puffin began to return. 8 Years later, that 1981 year, 5 Of Atlantic Puffin to this nesting.

This is the first time coming here in the last hundred years of breeding puffins

(Kress & Nettleship, 1988) . They subsequently arranged on the island to attract many false puffin birds. till 2009 Years have 123

Of Atlantic Puffin in Eastern Egg Rock The island nesting (Kress et al, 2009) .

Atlantic Puffin Gulf of Maine is not the only birds disappear. 20 The beginning centuries ago, Tern habitat in the Gulf of Maine and the number is much, but 1914 Years, After human hunting, predation impact of competition and other factors such as gulls, terns

populations of endangered (Kress,

1997) . With the proposed restoration projects seabird populations, 1980 In the local government for the restoration of tern populations, decided to Eastern Egg Rock Tern

Island to carry out Attracting projects. And Atlantic Puffin attract different is that tern chicks are not suitable for artificial breeding and migration, attract new method must be

selected. This time, they try to implement a community to attract technology that is made Stephen Kress Dr. invention. They first cleared of predators on the island all a

threat to Tern (Kress,

1983), Then laid a fake birds on the island and non-aggressive model

country / region Country / region	Items Number of projects
Wales Wales	1
France France	1
Antarctica Antarctica	3
Japan Japan	2
China Mainland China mainland	4
Taiwan, China Taiwan, China	2
Australia Australia	2
new Zealand New Zealand	twenty three

Playback of sound equipment, In order to attract adult terns nesting. The island monitors continuously monitor the habitat during the entire breeding, And terns predators, competitors and within the habitat vegetation management control. Then quickly attracted a common tern and Arctic terns to nest here (Kress, 1998) . Arrived 1981 Years, pink Tern (*Sterna dougallii*) Also attracted by nesting. Up 2010

Years in Eastern Egg Rock Attracting terns breeding ground habitat islands, including 714 For Common tern, 83 Arctic terns and 82

Of pink Tern (Kress et al, 2009) . Since then, There have been about 12

Item attract similar project in the Gulf of Maine, Many seabird populations to return.

4.2 Oregon giant red-billed Tern (*Hydroprogne caspia*) Artificial breeding herd migration

1997 year, Ornithologists find more and more giant red-billed terns flock to the border of Oregon and northwestern US state of Washington's Columbia River Rice Island breeding (Collis et al, 2002) . it's here, These giant red-billed terns eat a lot of salmon of the same Threatened

(*Oncorhynchus keta*) And rainbow trout (*Oncorhynchus mykiss*) Seedlings, It raised concerns of fishermen and fisheries sectors. In order to alleviate the growing problem of Ichthyornis conflict, 1999 Department of Fisheries and Wildlife, Oregon State University Daniel Roby The research team led by Professor Rice

Downstream Island 21km, Columbia River near the Pratas is the giant red-billed terns rebuild a breeding habitat. They vegetation removal side of the island, Exposed following Sandy (the giant red-billed terns favorite habitat), Sand laid on the solar panel and a sound playback device, And arranged 380 Only fake birds to attract Rice Red-billed

terns giant island to Pratas breed. After two years, Giant Red-billed terns from all Rice Pratas Island migrated to breeding (Roby et al,

2002) . In Pratas breeding giant red-billed terns because the closer to the estuary

waters, The type of food more diverse. 1999 with 2000 Years in Rice

Island breed of giant red-billed terns food, The proportion of salmon and steelhead seedlings are up 77% with 90% and 1999 , 2000 with 2001

The proportion of food in salmon and steelhead seedlings Pratas breeding giant red-billed terns decreased to 46% , 47% with 33% And reproductive success of giant red-billed terns has also been significantly improved (Roby et al, 2002) . Pratas attract terns project, Successful implementation of the giant red-billed terns breeding herd from Rice Pratas Island to migration, greatly eased Ichthyornis contradiction.

With the expansion of giant red-billed tern populations, They pose a threat to the salmon resource. 2011 year, And a giant red-billed terns began to implement a large migration project (Intermountain Communications, 2012) . The project site is located in the southeastern desert regions, Oregon

of Malheur lake. This is an inland freshwater lake, historically there have been huge Red-billed terns breeding records. In recent years, Asian carp (Including the introduction of Asian carp from (*Cyprinus carpio*) ,herring (*Mylopharyngodon piceus*) ,grass carp(*Ctenopharyngodon idella*) , Carp (*Carassius auratus*) And other kinds of fish) and more rampant in the United States, which also includes Malheur Lake Wildlife Refuge. How to control the growth and expansion of Asian carp has become the local administration headache. Pratas Red-billed terns attract huge successes gave them inspiration, They experimented with giant red-billed terns to control the population expansion of Asian carp. The project is still at Oregon State University Daniel Roby Professor of the team responsible for implementation. They built an artificial island in the middle of the lake, The island laying sand suitable for the giant

red-billed tern breeding habitat, And equipped with fake birds, sound playback device and manual monitoring huts. The first year of implementation of the project that is successful in attracting a large crowd from the Columbia River's giant Red-billed terns come breeding habitat.

Malheur Lake attract success not only mean a giant red-billed tern populations and habitats of the expansion, Also it means an increase in Columbia River salmon and Malheur Reduce Asian carp lake. In recent years, Pratas and Malheur Lake successful experience in Oregon and California got more promotion, It is a successful model of wildlife management, especially birds of solving the dispute or expanding the use of bird control fish

(Bird Research Northwest, 2015) .

4.3 new Zealand Mana Recovery Island burrowing seabirds and island ecosystems

Many of the island of New Zealand had been burrowing seabirds (such as procellariidae, petrels and common diving petrel Section Division bird) breeding habitat.

However, due to human influence, Many seabirds gradually disappeared from these islands. This not only led to a number of world class shearwaters nearly half are endangered, more 11 Kind even to the extent of critically endangered (Croxall et al, 1984) .

The area affected by the extinction of seabirds breeding seabirds not only itself, but also had a serious impact on island ecosystems located. Burrowing seabirds change of surface vegetation and burrowing and nesting islands by stepping plants, And through feces, vomit, abandoned eggs and carcasses and other marine transfer of nutrients to the land (Smith, 1976), To a large extent affected the island ecosystems, Including vegetation, invertebrates, reptiles and birds (Hawke et al, 1999) . Mana Island once had a variety of burrowing seabirds breeding, However, due to the invasion of exotic species and agricultural production activities, from seabirds Mana The island disappeared. In order to restore seabirds and island ecosystems, Island authorities decided Mana Island restoration project implementation burrowing seabirds (Miskelly, 1999) . Items from 1993 In the beginning, first of all attract a common diving petrel (*Pelecanoides urinatrix*) . They first played on the island sounds common diving petrel, 1997-1999 Between continuously transferred from other breeding grounds 239 Chicks to Mana The island (Miskelly &

Taylor, 2004) . To 2004 Years, 20 Only once in Mana Island of common diving petrel breeding grow up and leave back Mana island. 2008 In at least 10 On the common diving petrel breeding on the island. From 1997-2008 year, They were on the island altogether 8 Attracting species of shearwaters class, Others include Sin saw shearwater (*Pachyptila turtur*) , Gray face round tail Shearwater (*Pterodroma macroptera*) New Zealand round tailed shearwater (*P. pycrofti*) , Charles Island round tail shearwaters (*P. axillaris*) Red round tail Shearwater (*P. magentae*) , Brown mouth shearwater (*Puffinus gavia*) And Australia shearwater (*P. huttoni*) . A total of 1,791 Chicks moved to Mana Artificial island lair were feeding, there 1,546 Islands only grew. Up 2009 year, At least 68 Sexual maturity only after the birds return Mana Island breeding (Miskelly et al, 2009) .

4.4 Zhejiang Nirayama Islands critically endangered bird Chinese crested terns Attracting and population recovery

Chinese crested tern tern is the smallest number of families birds species, Less than the number of the world's population 50 only(Delany & Scott, 2002), Is IUCN Listed as critically endangered species. Chinese crested terns 1937 After years of Qingdao collected specimens up to the last 60 He disappeared for many years, until 2000 In the accident it was found in the Matsu islands in large mixed group of Great Crested Tern (*Thalasseus bergii*) In breeding (Liang et al, 2000) . 2004 In Zhejiang Museum of Natural History Chen Shui-hua, etc. (2005) Found the Chinese crested tern breeding colony in the archipelago, Zhejiang Nirayama investigation, The breeding population in 2007 After picking suffered because of human eggs left (Chen et al, 2009, 2010) . In order to effectively protect the Chinese crested tern breeding colony, 2013 year, Zhejiang Museum of Natural History and co-Oregon State University Xiangshan County of Ocean and Fishery Bureau in Nirayama Islands Attracting and implementation of restoration projects Chinese crested terns and great crested tern population. The project team selected as attract iron pier island habitat, the clean-up and reconstruction, Simulation of the Chinese crested tern and great crested tern breeding habitat, Laid fake birds model birds and playback audio equipment, and set up camp opposite was observed in the plot Taniyama iron pier island. Then successfully attracted 19 Chinese crested terns and only 2,000 More than just great crested terns to this breed, Eventually 1 Only the Chinese crested tern chicks and 600 More than just Great Crested Tern reproductive success Islands. 2014 In the beginning, Construction observation camps and living in the iron pier Island, Monitoring personnel stationed in the islands attract, achieve all-weather monitoring. 2014 There were 13 And for the Chinese crested terns 1,000 Multiple pairs of Great Crested Tern reproductive success, 2015 In the reproductive success and attract Chinese crested terns to rise 16 Correct, Great Crested Tern 1,000 For (Chen Shui-hua, etc., 2015) . continuous 3 The success of great significance to attract the number of Chinese crested tern population recovery.

5 discuss

Threatened seabird populations and habitat loss is a worldwide

The problem, About how to restore seabird populations and their habitats, European and American countries, especially in North America earlier carried out exploration in this area. Nestling transfer and communities to attract other important technology is the outcome of Attracting exploration. Attracting and habitat restoration technology applications seabird populations, As threatened and endangered seabirds brought the gospel. Especially the community to attract technology can effectively restore seabird populations in a short time and expand the scope of its existence, which for reduce the number of those populations, survival narrowed, restore breeding habitat destruction in population Division has a good application prospect.

5.1 Community Application Notes and limitations attract technology

Successful communities need to attract a wide range of technologies to ensure that: First, the near disappearance of species attract, so as to fully understand its habitat; Second, there must be appropriate for the islands attract the required different types of seabirds breeding habitat is different, a variety of factors including surface conditions, cave, vegetation cover and height of trees, The selected islands must have the conditions for transformation; third is to have enough time in advance to arrange the entire habitat, due to the false bait birds usually only have a role model for diurnal birds, and the sound of diurnal and nocturnal seabirds have a role, So the community to attract technology usually requires a way to fake a bird model with a combination of sound to attract birds, which need to have sufficient time to put fake birds model and sound playback device before the arrival of breeding seabirds; The fourth is to clear the entire island a threat to all species of seabird habitat after the completion of the arrangement, and to monitor whether there are any omissions of endangered species and birds of prey during the breeding period; Fifth, for the production of different birds and different breeding period and laid different models and false birds density adjustment model, may be laid as required within the habitat mirror, By increasing the fake bird reflection density; Sixth, throughout the breeding season, The island monitors require constant observation, at any time to monitor changes in a variety of conditions, According to the situation and solve the problem (Parker et al, 2007) .

In comparison, Simple to use and simple to use fake birds sound playback attract success rate is not high, were only 44% with 42% . If you combine the two, the success rate 80% the above.

Although the technology community to attract a lot of success stories, but its restoration projects, And most successful. This is because the terns reaction to the fake sound of birds and the model more quickly than other seabirds, often in the first year you can attract success; furthermore, terns show little attachment to the place of birth, This is to facilitate attract new habitats in the ground (Jones & Kress, 2012) . Tern species, widely distributed, the success of a project will lead to the implementation of similar projects. Technology community to attract less successful in luring other seabirds, mainly because

Other seabirds response model or the sound quickly enough, often takes a long time to adapt to new habitats, Making the entire project a longer period, Prone to financial difficulties. and so, Application technology community to attract to attract birds is a slow process, Supply of government attention and funding or organization concerned the entire project is the most important aspect.

5.2 Application Notes and limitations of the fledgling technology transfer

In comparison, Transfers typically take about chicks 5 More years to bear fruit, Ten years or even longer to confirm the effectiveness of monitoring, for those of seabirds mature later in particular. Gulf of Maine Atlantic Puffin attract, 4 After years before the year of puffins return, 8 After years before the first individual breeding, 35 Years later, Breeding pairs to reach 100 . Thus fledgling technology transfer requires long-term planning and enough patience. Secondly, Chicks transfer special requirements habitat, since the transfer of the chicks are mostly adapted burrowing seabirds, The goal should be suitable for nesting islands cave. In addition, Chick rearing chicks require manual transfer, Take appropriate artificial rearing techniques for different seabirds, Nestling in order to avoid unnecessary deaths.

5.3 Attracting and populations of seabirds recovery prospects

Attracting birds in the implementation of the project, Nizhao should be carried out for the birds and their habitats cited more specific preliminary studies, including the type of target bird habitat, nest site selection strategy, timetable and basic breeding information and breeding behavior. The selected habitat must be appropriate for the target birds and breeding habitat, The surrounding environment and food resources should meet the needs of the entire breeding colony. It must be integrated into the habitat suitability, food resources, human disturbance, predation risk as well as a variety of factors work facilitation. In particular, should choose the appropriate method based on ecological habits attract the target birds Should not blindly carry out.

Moreover, attract carried out in different regions, The risk of natural enemies are not the same. While birds of prey, snakes and rodents and other animals is the most prevalent threats to seabirds, but for specific projects, It should continue to undertake specific research. Conditions permitting, Close monitoring of weather, Can effectively control predators and other threats. In the project implementation process, Timely understanding of the dynamics of birds, eliminate threats, Is the key to success attract seabirds.

China has a long coastline, Across the subtropical and temperate climates, Numerous uninhabited islands can provide good habitat and breeding place for seabirds.

According to the existing literature and survey data, in the China Sea islands breeding seabirds namely, 4 Eye 13 Family 25 Species (Chen Shui-hua,

2010) . These include white-fronted shearwater (*Calonectris leucomelas*), Swinhoe's

Storm Petrel (*Oceanodroma monorhis*), Pelagic cormorant (*Phalacrocorax pelagicus*), Black-tailed gull (*Larus crassirostris*), Chinese crested tern , Great Crested Tern , Pink Tern , Black-naped tern

(*Sterna sumatrana*), Bridled tern (*S. anaethetus*), White top

Brown Noddy (*Anous stolidus*) And flat puffins (*Synthliboramphus antiquus*) Wait.

however, Because of the prevalence of human interference in China's coastal, marine pollution, overfishing, typhoons, rodents and snakes and other harmful threats, Seabird breeding areas and islands in the reduction, including many threatened species, the number of international and national key protected species of seabird populations, including the Chinese crested tern decreased significantly (Chen Shui-hua,

2010) . Currently, Application Community to attract skilled in Zhejiang Nirayama archipelago implementation of large crested terns and the Chinese crested tern population Attracting and recovery technology has achieved initial success.

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references

Bird Research Northwest (2015) Monitoring and Predator Control at the Corps-Constructed Caspian Tern Islands in Southeastern Oregon and Northeastern California, 2015 Annual Report. http://www.birdresearchnw.org/2015%20Predator%20Control%20Final%20Report_v12.pdf. (accessed on 2016-12-22)

Chen SH (2010) Status and protection of the breeding seabirds in China Seas. *Bulletin of Biology*, 45 (3), 1-4. (in Chinese) [Chen Shui-hua (2010) China Sea situation and protection of breeding seabirds. *Biology briefing*, 45 (3), 1-4.]

Chen SH, Fan ZY, Lu YW (2015) The population of the Chinese crested tern is close to one hundred. <http://www.chinabird.org/news/chinese%20tern%202015.htm>. [Chen Shui Hua, Fanzhong Yong, Lu Yi Wei (2015) Chinese crested terns re-attract breeding success, population approaching one hundred. <http://www.chinabird.org/news/chinese%20tern%202015.htm>.] (accessed on 2016-12-22) Chen SH, Chang SH, Liu Y, Chan S, Fan ZY, Chen CS, Yen

CW, Guo DS (2009) Low population and severe threats: status of the critically endangered Chinese crested tern

Sterna bernsteini. *Oryx*, 43, 209-212. Chen SH, Fan ZY (2013) Chinese crested tern. *Chinese Journal*

of Zoology, 48, 788-789. (in Chinese) [Chen Shui-hua, Fan Zhongyong (2013) Chinese crested tern. *Journal of Zoology*, 48, 788-789.]

Chen SH, Fan ZY, Chen CS, Lu YW, Wang ZD (2010) A new breeding site of the critically endangered Chinese crested tern *Sterna bernsteini* in the Wuzhishan Archipelago, eastern China. *Forktail*, 26, 132-134. Chen SH, Yan CW, Fan ZY, Chen CS, Zhang FG (2005) The

breeding colony of Chinese crested tern at Jiushan Archipelago

- in Zhejiang. *Chinese Journal of Zoology*, 10 (1), 96-97. (in Chinese) [Chen Shui-hua, Yen Chung-wei, Fanzhong Yong, Chen pines, Zhangfang Gang
(2005) Zhejiang Nirayama Islands crested tern breeding colony preliminary survey report. *Journal of Zoology*, 10 (1), 96-97.]
- Collis K, Roby DD, Craig DP, Adamany S, Adkins JY, Lyons DE (2002) Colony size and diet composition of piscivorous waterbirds on the lower Columbia River:.. Implications for losses of juvenile salmonids to avian predation *Transactions of the American Fisheries Society*, 131, 537-550 Croxall JP, Prince PA, Hunter I, McInnes SJ, Copestake PG
(1984) The seabirds of the Antarctic Peninsula, Islands of the Scotia Sea and Antarctic Continent between 80 ° W and 20 ° W:.. Their status and conservation ICBP Technical Publication, 2, 637-666.
- Croxall JP, Trathan PN, Murphy EJ (2002) Environmental change and Antarctic seabird populations. *Science*, 297, 1510-1514.
- Delany S, Scott D (2002) *Waterbird Population Estimates*, 3rd edn. Wetland International, Wageningen, The Netherlands. Donlan CJ, Wilcox C (2007) Complexities of costing eradication. *Animal Conservation*, 10, 154-156.
- Frederiksen M, Harris MP, Daunt F, Rothery P, Wanless S (2004) Scale-dependent climate signals drive breeding phenology of three seabird species. *Global Change Biology*, 10, 1214-1221.
- Gaston AJ (2004) *Seabirds: A Natural History* Yale University Press, New Haven.
- Hasegawa H, Watkinson AR (1982) The short tailed albatross, *Diomedea albatrus*, its status, distribution and natural history. *American Birds*, 36, 806-814.
- Hawke DJ, Holdaway RN, Causer JE, Ogdens S (1999) Soil indicators of pre-European seabird breeding in New Zealand at sites identified by predator deposits. *Australian Journal of Soil Research*, 37, 103-113.
- Howald G, Donlan CJ, Tershy BR, Croll DA, Russell J, Saunders A, Clout M (2007) Invasive rodent eradications on islands. *Conservation Biology*, 21, 1258-1268. Intermountain Communications
(2012) New man-made island in Malheur Lake attracting Caspian terns from estuary's East Sand Island. *The Columbia Basin Fish & Wildlife News Bulletin*. <http://www.cbulletin.com/421296.aspx>. (accessed on 2016-12-22)
- IUCN (International Union for Conservation of Nature) (2009) The IUCN Red List of Threatened Species <http://www.iucn.redlist.org> (accessed on 2016-12-22).
- Jones HP, Kress SW (2012) A review of the world's active seabird restoration projects. *The Journal of Wildlife Management*, 76, 2-9.
- Jones HP, Towns DR, Bodey T, Miskelly CM, Ellis J, Rauzon MJ, Kress SW, McKown M (2011) Recovery and restoration on seabird islands In:.. *Seabird Islands:.. Ecology, Invasion, and Restoration* (eds Mulder CPH, Anderson WB, Towns DR, Bellingham PJ), pp 460-531 Oxford University Press, Oxford.
- Kress SW (1983) The use of decoys, sound recordings and gull control for re-establishing a tern colony in Maine. *Colonial Waterbirds*, 6, 185-196.
- Kress SW (1997) Using animal behavior for conservation: case .. Studies in seabird restoration from the marine coast, USA *Journal of the Yamashina Institute for Ornithology*, 29, 1-26 Kress SW (1998) Applying research for effective management: case studies in seabird restoration In:.. *Avian Conservation:.. Research and Management* (eds Marzluff JM, Sallabanks R), pp 141-154 Island Press, Washington, DC Kress SW, Borzik RV, Hall CS (2009) *Egg Rock Update 2009*. National Audubon Society, Ithaca, New York. Kress SW, Nettleship D (1988) Re-establishment of Atlantic **puffins (*Fratercula arctica*) at a former breeding site in the gulf of Maine.** *Journal of Field Ornithology*, 59, 161-170. Liang CT, Chang SH, Fang WH (2000) Little known oriental bird:.. discovery of a breeding colony of Chinese crested tern *Oriental Bird Club Bulletin*, 32, 18. Miskelly CM (1999) Social constraints on access to mates in a **high density population of New Zealand Snipe (*Coenocorypha aucklandica*).** *Notornis*, 46, 223-239. Miskelly CM, Gummer H (2013) Attempts to anchor pelagic **fairy prions (*Pachyptila turtur*) to their release site on Mana Island.** *Notornis*, 60, 29-40.
- Miskelly CM, Taylor GA (2004) Establishment of a colony of **Common diving petrels (*Pelecanoides urinatrix*) by chick transfers and acoustic attraction.** *Emu*, 104, 205-211. Miskelly CM, Taylor GA, Gummer H, Williams R (2009) **Translocations of eight species of burrow-nesting seabirds (genera *Pterodroma*, *Pelecanoides*, *Pachyptila* and *Puffinus*: Family Procellariidae).** *Biological Conservation*, 142, 1965-1980.
- Nogales M, Martin A, Tershy B, Donlan CJ, Veitch D, Puerta N, Wood B, Alonso J (2004) A review of feral cat eradication on islands. *Conservation Biology*, 18, 310-319. Parker MW, Kress SW, Golightly RT, Carter HR, Parsons EB, Schubel SE, Boyce JA, McChesney GJ, Wisely SM (2007) Assessment of social attraction techniques used to restore a common murre colony in central California. *Waterbirds*, 30, 17-28.
- Roby DD, Collis K, Lyons DE, Craig DP, Adkins JY, Myers AM, Suryan RM (2002) Effects of colony relocation on diet and productivity of Caspian terns. *Journal of Wildlife Management*, 66, 662-673.
- Rolland C, Danchin E, Fraipont MD (1998) The evolution of coloniality in birds in relation to food, habitat, predation, and life-history traits: a comparative analysis *The American Naturalist*, 151, 514-529..
- Schreiber EA, Burger J (2001) *Biology of Marine Birds*. CRC Press, Boca Raton.
- Smith VR (1976) The effect of burrowing species of Procellariidae on the nutrient status of inland tussock grasslands on Marion Island. *Journal of South African Botany*, 42, 265-272.