EEP15/WG1/WP7

WITH ATTACHMENTS

EEP15
Working Group 1
WP – Bird Deterrents

1. Scope;

- Prepare information pertaining to effectiveness of bird deterrents, specifically by identifying measures that authorities are using or have trialed, and the measure of success or level of effectiveness.

2. Requirements for bird deterrents;

- Helipads
- Lanterns / AtoNs
- Solar panels
- Structural components.

3. Methods trialed or being practiced

Below are details of methods currently being practiced, or previously trialed, and the level of effectiveness.

- **Sweden**
  - See Input Paper (Attachment 1), which outlines attempts to mitigate problems with cormorants and bird lime at their lighthouse. The input paper documents issues with identifying effective measures. Sweden commissioned a study by university student utilizing range of different methods with mixed results;
    - Mocking birds - Unsuccessful
    - Gas cannons – Initial results were promising however initial results diminished and the gas cannon was later decommissioned.
    - Sound scarers – Was trialed using bird distress calls. After second month, cormorants completely ignored the sound scares. Conclusion was that the bird scares were ineffective.
    - Methods
    - Laser guns – possible use of laser guns was researched, however further investigation of both studies, showed that suppliers were not confident on the use of laser guns for bird deterrents.
    - Mobile phone base station – First site showed signs of effectiveness, however second site didn't, therefore evidence of electro-magnetism as an effective bird deterrent was inconclusive.
    - Shared for all of the tested methods are their inability to disperse birds in a time consistent way.

- **Japan**
  - See Input Paper 2 (Attachment 2), outlining tests of bird deterrent devices on 239 AtoNs.
    - Devices included ‘Pyramidal metal attachments’ and attachments consisting of ‘wire or synthetic fiber’. Mixed results and details of level of effectiveness for type of deterrent are provided in the Input paper.
    - Vertical mounting of solar panels was also successful but required additional solar components to address power loss. In some cases, there was no sufficient room for additional solar panel arrays.
- **Australia**
  - A variety of different methods have been used by AMSA.
    - Bird rollers – mounted on solar panels and structural components on a variety of different structure. Bird rollers have proven reasonably successful.
    - Vertical mounting of solar panels – successful but requires additional solar components to address power loss.
    - Installing cones on top of flat lantern services, to remove areas for bird purchase

Figure 1. Bird Rollers installed in Australia

Figure 2. Adding cones to flat lantern surfaces

- **Papua New Guinea**
  - Problem with severe bird lime coverage encountered in locations in PNG on recently refurbished navigation aids. Several different methods trialed.

    - Heavy gauge stainless spikes proved too effective and resulted in birds being impaled on spikes and dying, covering solar panels and lanterns, resulting in outages
    - Commercially available bird spikes out of Australia have proved successful; however method of attaching bird spikes has required some changes.
    - Must be noted that all sites visited bi-annually, and if the maintenance visits were extended it is possible the method of adhesion may fail.
- Trinity House
    - Adaptation of blue paint which has proven successful against deterring birds / cormorants from using helipad.
    - Trinity House has been requested to provide details on whether there is a particular tone / shade of blue used.
- Brazil
    - Brazilian authorities used a Simple scheme for preventing bird fouling to obscure solar panels or lens installed on buoys.
    - Practical observations indicated that seagulls tend to defecate in nearly horizontal bursts, whilst perched on steel buoy guard rails.
    - A simple elevating platform proved effective in reducing the fouling effect that, otherwise, rendered the lanterns unusable after a short period of installation, mainly because of insufficient recharging.
    - The figures below show the arrangement without the elevating platform, to the left, and with the elevating platform, to the right.

Figure 3. Methods used by Brazilian authorities

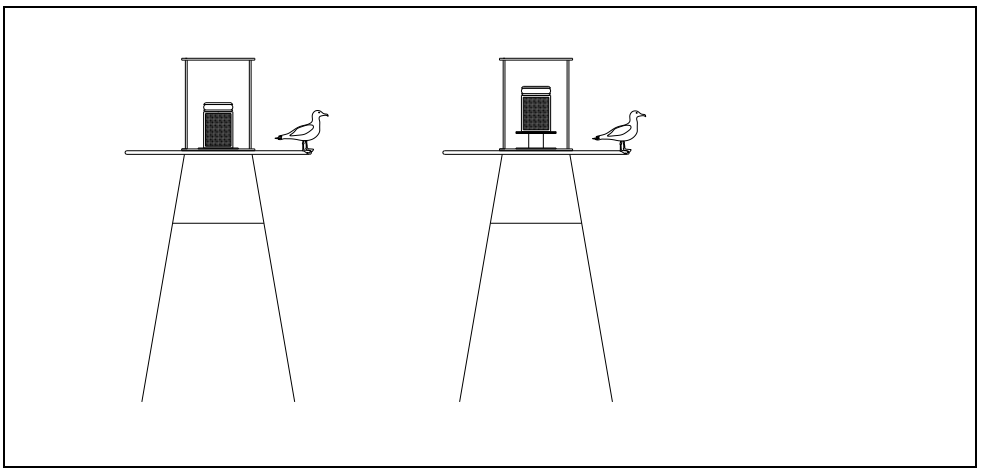

Figure 4. Cone installed on top of lantern in Norway.

4. RECOMMENDATION

- In order to increase the amount of information available on this subject, other authorities should be consulted for information on the issue of bird deterrents, particularly on deterrents or bird control measures previously used or currently implemented, including the level of effectiveness.
- If possible, information on any situations where the problem is specific to a certain species of bird (such as cormorants) which may enable countries to better identify control measures if the bird issue is specific to one type of bird.

ATTACHMENT 1 – INPUT PAPER

Information of Cormorants at Swedish lighthouses

Great cormorant birds are frequent visitors to Swedish lighthouses. They have found our lighthouses to be a perfect resting and outlook spot while searching for food.

We have now an increasing problem with bird droppings which are left at the lighthouses.
The problem is severe. When entering one of those lighthouses you have to have protective disposable clothes. The bird dropping are soft and is unbelievably smelly, everything that you come near by after your mission will be affective by the smell!

The spilling is a threat to the maritime safety red lighthouses become very quickly white. We are struggling with solar panels and alternative energy supply to create a good light range! But all this work is of no use when the Cormorants have been visiting the lighthouse.

During the last years the bird has spread very rapidly and is now habituated longer north then usual.

To analyse the best measure to take, we invited a university student do a dissertation on our problem. His report with analysis is attached.

To scare the birds away from the lighthouse would have been the easiest way to deal with this problem, but it did not work as we wished. We are now taking measure in mechanical terms to prevent the Great Cormorant from landing on the lighthouse, it involves more work but the result is better.

We are now putting up sheep fence and also using stainless welding thread collected in small bunches. The long thin thread is moving in the wind and has a good preventive effect.

Christian Lagerwall
28/09/09

Cormorants at Swedish lighthouses

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Analysis of the current situation and an evaluation of scarecrows

Henrik Ruul

2009-08-24

Contents

1 Current situation

The Swedish Maritime Administration is responsible for the maintenance and operation of lighthouses in Sweden. Currently there are close to one thousand lighthouses in operation scattered along the Swedish coastline. Even though all of these lighthouses are automated they do require regular overhaul by personnel from the Swedish Maritime Administration.

Great cormorant birds are frequent visitors to Swedish lighthouses. The birds use lighthouses as resting and lookout spots while searching for food. Different reasons that causes lighthouses to be popular cormorant gathering places are further described in the next section.

Figure 1: Cormorant droppings on lighthouse

An obvious side effect of the visiting cormorants are the abundant amounts of bird droppings on the lighthouses. Cormorant droppings leave an unpleasant odour and are considered to be an inconvenience by Swedish Maritime Administration personnel. Droppings also cause increased cleaning and repainting needs of lighthouses.

2 Cormorant birds

A cormorant is a seabird, more precisely a pelican bird feeding solely on fish. The latin name of the bird is phalacrocorax carbo, literally meaning black bald raven.[Breife, 1993]. The body length of an adult cormorant is between 80 to 100 cm and the wingspan can be up to 160 cm, so cormorants are relatively large seabirds.

The cormorant bird have populated the area around the Baltic sea for over nine thousand years[Engström, 2001]. The bird was extinct from Sweden by man sometime in the end of the nineteenth century[Fiskeriverket, 1998]. Contributing factors included excessive hunting and intentional attempts to exterminate [Jonsson, 1998].

The reinstatement started cautiously in 1940 and accelerated in 1980. The number of breeding cormorant couples in Sweden had in year 2006 reached 49 000, the highest number in Europe. It is actually a subspecies of the great cormorant, the phalacrocorax carbo sinensis, that is responsible for this impressive comeback. The cormorant is currently protected by the Eu's bird directive. [Johansson, 2000]

Figure 2: A Great Cormorant drying its plumage

Cormorants feed by catching fish in lakes and oceans, sometimes diving to depths exceeding fifty meters. The ability to swim freely is greatly improved by the fact that the cormorant's plumage is adhesive to water, this is in contrast to regular seabirds which have a nonadhesive plumage[Jonsson, 1998]. Because the plumage is not waterproof cormorants cannot allow themselves to stay wet for longer periods of time, this would make them subject to hypothermia. To counter this problem cormorants frequently position themselves in a very characteristic pose to dry their plumage, this characteristic pose can be observed in figure 2.

Also characteristic for cormorants are the unpleasant odour caused by their plentiful amount of droppings. Figure 3 displays another characteristic phenomena of the cormorant's faeces, it is very loose in consistency and therefore

dyes the underlying ground white. These two factors are the main reasons why cormorants visiting lighthouses are a case of concern for the Swedish Maritime Administration.

Figure 3: Great Cormorants on Havreön, Finland

An adult cormorant has, apart from man, only one natural enemy. A recent study [Helander, 2000] has revealed that cormorants constitute a significant part of the sea eagle's regular diet.

3 Evaluation of scarecrows

3.1 Mocking birds

The Swedish Maritime Administration have tested six plastic eagle owls at six different lighthouses in Sweden. An unknown number of these plastic owl were modified to rotate when the wind changed direction. Such a rotating plastic owl is seen in figure 4.

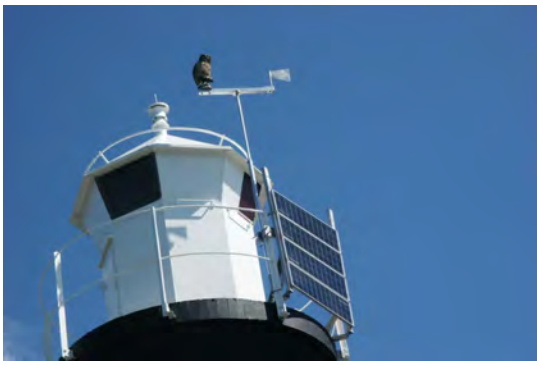

Figure 4: A plasitc eagle owl

An evaluation of a plausible effect on the number of visiting cormorants were carried out after the installation of the plastic owls. Unfortunately no data containing the number of visiting birds on the lighthouses before the installation were recorded. Also the point of time for the installation was not noted.

The evaluation at these six lighthouses reveals that a plastic owl is ineffective as a cormorant scarer. Cormorants remained a very much common sight at all of these lighthouses some time after the installation of the plastic owls. A Swedish cormorant expert, Doctor Henry Engström at Uppsala University, remarks that plastic eagle owls would be very unlikely succeeding in scaring cormorants since not even real eagle owls constitute a threat to an adult cormorant. Doctor Engtröm further believes it will be difficult to find any way to scare cormorants of lighthouses without seeing them habituate to the scarecrow, given enough time to do so.

3.2 Gas cannons

A gas cannon ignites liquified petroleum gas to create a sound effect that scares off birds. It can also be programmed to ignite gas at random intervals to make it more efficient. Figure 5 illustrates a gas cannon from Nordanvik AB.

An evaluation done by Viltskadecenter (a service center that aims at investigating and preventing damages caused by wildlife) revealed that gas cannons are an effective way to disperse birds. Viltskadecenter tested gas cannons on

Figure 5: A gas cannon from Nordanvik

a field, frequently used by crane birds, outside the town of Örebro in central Sweden. The test outcome showed an 84% reduction of number of visiting crane birds. Unfortunately a potential habituation effect was not throughly examined since the experiment only lasted for 30 days.

The Swedish Maritime Administration installed one gas cannon at the lighthouse Svinbådan outside the city of Helsingborg. The Svinbådan lighthouse is very popular among cormorant birds all the year round. The initial effect of the gas cannon was very good, according to Martin Samuelsson captain of the service ship Scandica. After some time the promising initial effect diminished and the gas cannon was later decommissioned. The cormorant birds displayed a clear and indisputable habituation effect.

3.3 Sound scarers

The Swedish Maritime Administration has tested several bird scarers that uses sound effects, such as bird distress calls, to repel birds. 6 different test sites was identified and are displayed in table 1 below. All of them, except the first one, are a US made product named Bird Gard Super Pro. The Bird Gard Super Pro plays bird distress calls at random intervals and at random frequencies. Unfortunately the usage of these products was not very well documented which made it difficult to reach a solid conclusion.

As can be observed in table 1 the data is incomplete and inconsistent making it impossible to determine whether the Bird Gard Super Pro is effective or not. Therefore another experiment was carried out, using a slightly modified Bird Gard Super Pro at the lighthouse Flintrännan 16 near the Öresund Bridge. The Bird Gard Super was modified to allow it to be remote controlled by mini-call and GSM Internet. It was therefore possible to not only switch the unit on and

Table 1: Sound scarers

Device	Lighthouse	Location	Effect	Time period	Installer
Unknown	Flintrännan 7	Öresund	None	Unknown	Scandica
Birdgard SP	Fladen	Halland	Unknown	October 2007	Scandica
Birdgard SP	Falsterbo rev	Falsterbo	Unknown	November 2007	Scandica
Birdgard SP	Revanschen	Sandhamn	Unknown	Unknown	Baltica
Birdgard SP	Bredgrund	Landsort	Unknown	Unknown	Baltica
Birdgard SP	Västerbådan	Västervik	Yes	November 2007	Arkö 833

off but also to change the type of bird distress called being played. Further a surveillance camera was installed to monitor the experiment close by.

After two months of testing, the first month without using the Bird Gard Super Pro and the second month with the unit turned on, the cormorants completely ignored the distress calls being played. Even attempts to manually scare off the birds, by changing the sound used by Bird Gard Super Pro, failed. Using the surveillance camera some moving pictures with sound was recorded from the test site. The film displayed birds resting on the lighthouse while the sound scarer operated at maximum efficiency, apparently uninfluenced.

It is therefore considered very unlikely that sound scarers are an effective way of bird control on lighthouses.

3.4 Lasers

The French company Desman markets and manufactures lasers designed specifically for bird control. An example of a Desman bird control laser is shown in figure 4.

Figure 6: A Desman laser

Inquiries was sent to Desman reference customers listed on their web page asking about their experience of the Desman laser. Two answers was received, one from the U.S. Department of Agriculture (UDA) and one from Bayerische

Landesanstalt für Landwirtschaft (BLL) in Germany. Both UDA and BLL invested in a laser to conduct their own experiments on its possible use as cormorant scarer.

Doctor Manfred Klein at BLL reveals that the experiment with the Desman laser has been aborted and that BLL classifies this technique to be ineffective. BLL used the Desman laser on breeding cormorants and was unable to make them abandon their nests.

Andy Radomski, field biologist at UDA, has had a slightly different experience of the Desman laser. According to Andy Radomski the laser was indeed successful at scaring of cormorants, at least temporarily. But despite this initial success UDA does not consider the Desman laser to be an effective solution since the effect is not long lasting and too local for their intended use.

4 Electromagnetism

Anecdotal evidence from employees at the Swedish Maritime Administration suggested that electromagnetism from mobile phone base stations installed at lighthouses seemed to deter cormorants. The information regarded two different lighthouses both with mobile phone base stations installed, Flintrännan 6 lighthouse in Öresund and the Svinbådan lighthouse outside the city of Helsingborg.

For such an effect to be plausible birds must at least be able to perceive the electromagnetism radiated from the mobile phone base stations.

4.1 Birds and electromagnetism

It is confirmed that many birds are able to use magnetic radiation as a source of information while navigating [Wiltschko, 1968]. The earths magnetic field that birds use while navigation is a very weak static magnetic field. This is in contrast to the oscillating electromagnetic field emitted from the mobile phone base stations used at the lighthouses in question. The base stations at Flintrännan 6 and at the Svinbådan lighthouse only operates at the 1800Mhz band.

How birds are able to use information gathered from the earths magnetic field is not fully understood. Two completely different receptor systems seems most plausible [Ritz, 2004]. One of them includes the ferromagnetic mineral magnetite. Magnetite happens to be a good absorber of electromagnetic radiation for frequencies between 0.5 to 10GHz [Kirschvink, 1996].

Scientific literature regarding a possible link between birds behavior and exposure to electromagnetic fields was studied. The study yielded little or no support for such an effect. Only one article claiming such an effect was found [Everaert, 2007]. This article claimed that sparrows tend to avoid nesting close to mobile phone base stations.

4.2 Lighthouses with mobile phone base stations

The Flintrännan 6 lighthouse is one of several lighthouses that constitute the Flintrännan international channel in Öresund. This particular lighthouse should according to information received have far less visiting cormorants than its nearby neighbors. Presumably due to the presence of a mobile phone base station.

An attempt to compare the number of visiting cormorants at Flintrännan 6 with the lighthouse Flintrännan NO (only 2,3 nautical miles from Flintrännan 6) was performed. A distinct difference in amount of faeces between these two lighthouses was noticeable, Flintrännan 6 being the one having significantly less faeces.

Further, cormorant birds on Flintrännan 6 was monitored with a surveillance camera connected to the Internet via wireless 3G technology. During several months of surveillance the camera only caught a handful of birds visiting the lighthouse, far less than expected in this by cormorants densely populated area.

The other lighthouse equipped with a mobile phone base station, Svinbådan, was located further out to sea than Flintrännan 6. The mobile phone base station resembled the one installed at Flintrännan 6. Martin Samuelsson, captain of the service ship Scandica and a frequent visitor to Svinbådan, stated that cormorants are a very much common sight at this lighthouse.

Figure 7: A mobile phone base station at Flintrännan 6

5 Results and disscusion

5.1 Scarecrows

The evaluation of previously tested scarecrows yielded a poor result. First of all mocking birds, in this case plastic eagle owls, proved to be completely ineffective at keeping cormorants away from lighthouses.

A gas cannon initially showed promising results but it soon became obvious that this solution was not time constant. The cormorants were habituated to the gas cannon quite rapidly and the cannon was dismantled.

Also scarecrows using bird distress calls were tested and dismissed. The tested model, Bird Gard Super Pro, proved to be unable to scare cormorants, at least after 30 days of consistent use. Whether or not the Bird Gard Super Pro had an initial effect that decayed with time was not fully understood.

Finally the use of laser scarecrows was examined to some extent. The result of that examination was discouraging.

As cormorant expert Henry Engstöm at Uppsala Univeristy pointed out, it does look hard finding a way to scare the cormorants away from lighthouses. Cormorants appears to benefit from resting on lighthouses just a little bit to much for us to force them to leave. The fact that they does not even abandon a lighthouse equipped with a powerful gas cannon seem to support this assumption.

Shared for all of the tested methods are their inability to disperse birds in a time consistent way. Cormorants tend to get used to scarecrows installed on lighthouses, they tend to habituate. Contributing factors to this habituation effect are presumed to be partly that lighthouses constitute a favorable place for cormorants and also that lighthouses are more ore less completely isolated from human presence.

The tests performed do however have some flaws. It is possible that a mocking bird resembling a sea eagle instead of a eagle owl would be more successful. This since a genuine sea eagle poses a real threat to a cormorant which an eagle owl does not. Although even if the initial effect possibly could be improved it is assumed to be very likely that the cormorants would habituate in the long run.

5.2 Electromagnetism

Whether or not electromagnetism from mobile phone base stations actually deter birds is not fully understood. Observations from Flintrännan 6 and the fact that birds are capable of perceiving at least some magnetic fields seem to support this assumption. Although cormorants does not seem to be too disturbed by electromagnetism since cormorants have been spotted at the Svinbådan lighthouse.

More data needs to be collected before it is possible to reach any solid conclusions.

6 Future areas of interest

For future work I suggest less focus on scaring techniques and more on alternative types of ideas. The Great Cormorant is a relatively large seabird that has webbed feet and it is not particularly agile while airborne. These characteristics could possibly allow measures that prevents cormorants from landing on lighthouses. Possible measures could include bird spikes and trip wires. If such a measure succeeds it would be unlikely to display any habituation effect.

A lighthouse is generally a building with few suitable landing spots for cormorants. Most parts of a lighthouse's surface are vertical and therefore completely inaccessible for birds. Preventing cormorants from accessing lighthouses with lets say birds spikes is not really a problem. The problem is doing so while still allowing access for service personnel.

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ATTACHMENT 2 – INPUT PAPER

Preventive Measures against smear from seabird droppings on PV panels

Japan Coast Guard

1. Introduction

A number of aids to navigation have been using solar power as a power source in recent years, and smear from seabird droppings on PV panels not only reduces the effectiveness during the daytime but influences nighttime signaling functions caused by insufficient charge from PV panels.

We came out with various countermeasures in order to establish preventive methods against smear from seabird droppings, and conducted on site test analysis for a year and a half.

2. Analysis methods and evaluations

The countermeasures described in Material 1. were tested for 239 aids to navigation (mainly buoys and Resident buoys), which were heavily smeared by seabird droppings.

And the comparison of the smear before and after the tests is as follows:

Lighted buoy

Resident buoy

(1) The countermeasures against smear caused by seabirds perchingon PV panels.

"(a) Pyramidal metal attachments" and "(c) Standard bird control metal attachments" are effective as countermeasures against smear caused by seabirds perching on PV panels. And the combination of these two, "A-3 pyramidal type and standard bird control (20W model) type" is the most effective countermeasure.

The pyramidal metal attachments for both 20W and 50W are expensive, but considering that they are durable, reusable and easy to install, they are the most effective countermeasures.

"(b) Standard bird control metal attachments with strings of wire or synthetic fiber, etc." have reasonable prices, since they are only for the cost of standard bird control metal attachments plus wire. But many incidents are reported of the devices being knocked down by seabirds, which indicates insufficient effectiveness against large seabirds, etc. The installation method for wires needs to be fully and sufficiently planned out.

(2) The countermeasures against smear caused by birds perching on nearby PV panels.

① Countermeasures to take for topmarks
"(f) Metal strings such as wires, etc." are installed mainly as a countermeasure to protect topmarks, and it is proved to be effective.

But some seabirds were observed to perch between metal spikes on the topmarks despite installed metal attachments, thus these metal spikes need to be modified, or other measures, such as commercially available plastic attachments, should be considered.

②Countermeasures to take for topmark spars and handrails/protection frames
"(d) Commercially available plastic attachments" is the most effective countermeasure to take for topmark spars and handrails/protection frames. This is the most effective countermeasure considering ease of installation and a durability of 5 years.

"(e) Fastening attachments" is an effective countermeasure for protecting handrails and frames against birds perching on nearby PV panels. It is cheaper than commercially available plastic attachments and some of them have a durability and weather resistance of 10 years.

But they need to be installed in large amounts without big gaps in between to be effective, which requires extensive labor. Thus "(d) Commercially available plastic attachments" is the way to go.

(3) Countermeasures to take using installation methods for PV panels

① Resident buoys
Perpendicular installation of PV panels for resident buoys is the most effective countermeasure for preventing smear caused by bird droppings and dust, etc.
Resident buoys are exposed to enough solar radiation because of a small amount of rotational motion and pitching/rolling of the Resident buoys. But reduction of power generations from perpendicular installation of PV panels is not avoidable compared to level installation due to the change of angle of sun light incidence. Installation of extra panels and battery capacity needs to be considered for each mark in order to obtain necessary power generations.

Some Resident buoys do not have enough space for extra PV panels, depending on the shape. Countermeasures (1) or (2) will be implemented to prevent smear in such cases.

② Lighthouses and Offshore fixed lights
Perpendicular installation of PV panels for lighthouses and Offshore fixed lights, as well as Resident buoys, are considered to be the most effective countermeasures for preventing smear. Perpendicular installation of PV panels for lighthouses and Offshore fixed lights will be considered, but if that is difficult, countermeasure (1) or countermeasure (2) will be taken.

③ Lighted buoys
Lighted buoys are exposed to a large amount of rotational motion and pitching/rolling, which causes variability of the necessary insolation to generate sufficient electricity. Perpendicular installation of PV panels is not a choice in this case. The countermeasure of (1) or (2) will be implemented to prevent smear.

3. Conclusions

According to the results (see Material 2) based on the effectiveness proved by onsite test analysis and factors such as cost and durability, etc., We decided to implement the following countermeasures for aids to navigation that are heavily smeared with seabird droppings:

(1)Lighted buoys

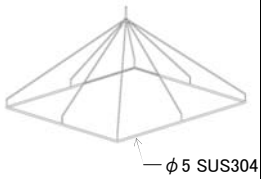
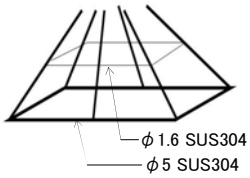
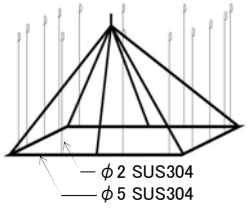
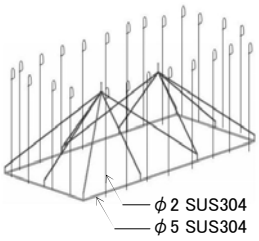
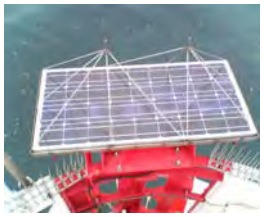
(a) Combination of "Pyramidal metal attachments " and "Standard bird control metal attachments" for PV panels.
(b) "Metal strings such as wires, etc." for topmarks.
(c) "Commercially available plastic attachments" for topmark spars and handrails/protection frames.

(2)Resident buoys, lighthouses and Offshore fixed lights

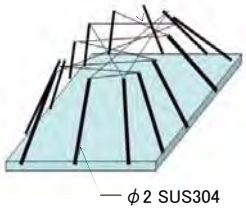
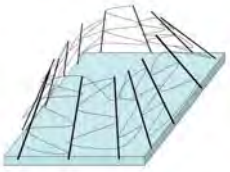
(a) Perpendicular installation of PV panels. If it is difficult to do so because of insufficient space for additional PV panels, etc., the above mentioned countermeasure "(a)" will be implemented.
(b) "Metal strings such as wires, etc." for topmarks.
(c) "Commercially available plastic attachments" for prop of topmark and handrails/protection frames.

(1) The countermeasures against smear caused by birds perching on PV panels

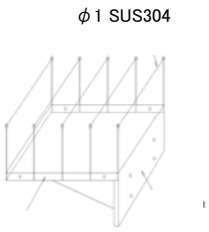
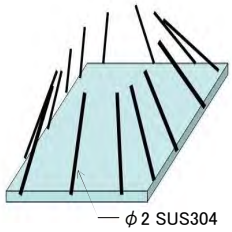
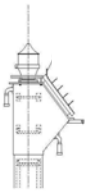
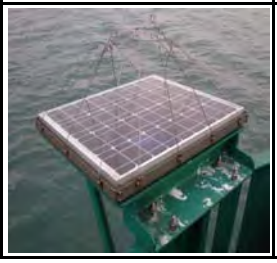
(a) Pyramidal metal attachments

A－1	A－2	A－3 (20W model)	A－4 (50W model)
			
			

(b) Standard bird control metal attachments with strings of wire or synthetic fiber, etc

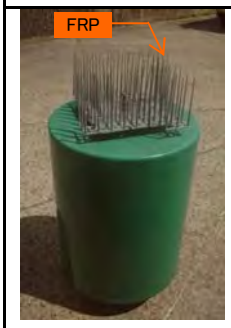
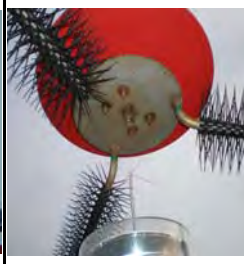
B－1	B－2	B－3	B－4
			
			

(c) Standard bird control metal attachments

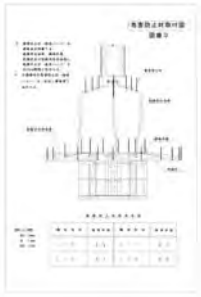
C－1 (10W model)	C－2	C－3
		
		

(2) The countermeasures against smear caused by birds perching on nearby PV panels.

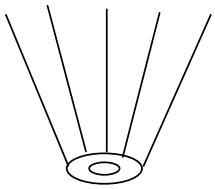
(d) Commercially available plastic attachments

D－1 Topmark	E－1 Prop of Topmark	E－4 Prop of Topmark (all around)	F－1 Handrails/protection frames	G－1 Marking system
				

(e) Fastening attachments

E－2 Prop of Topmark	F－2 Handrails/protection frames	G－2 Marking system
		

(f) Metal strings such as wires

D－2 Topmark	E－3 Prop of Topmark
	

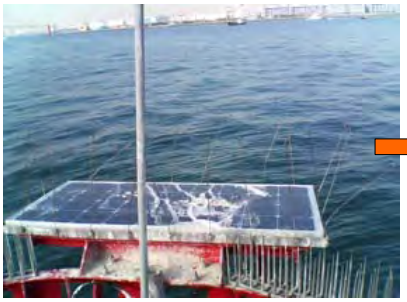
(g) etc.

I－1 PET bottle pinwheel


(3) Countermeasures to take using installation methods for PV panels

(h) Perpendicular installation of PV panels

Before



After

Results based on the effectiveness proved by onsite experiment analysis and factors

Material 2

Countermeasures		Installation place	Type		Number of installations	Effectiveness(※)			Cost	Durability	Recycling	Difficulty	Evaluation	備考
						Effective	A little Effective	Ineffective	○：cheap ×：Expensive	◎：Best ○：Good △：Nomal	○：Possible △：A little possible ×：	○：Easy △：Nomral ×：Difficult	○：Adoption ×：No adoption	
Countermeasures against smear caused by birds perching on PV panels	Pyramidal metal attachments	PV panels	A	1	7	86%	0%	14%	×	◎	○	○	×	
			A	2	5	100%	0%	0%	×	◎	○	○	×	
			A	3	51	100%	0%	0%	×	◎	○	○	○	・This result has reliability because the execution part is more than A-1 and A-2. ・the initial cost is expensive. But it will be recycle because the durability is high,
			A	4	3	0%	67%	33%	×	◎	○	○	○	・It was not effective in each execution part. ・Some birds may stays easily because the panel for 50W is wide ・It seems that the effect can be expected by simultaneous using the steps Torijo disregarding of A-2.
	Standard bird control metal attachments with strings of wire		B	1	41	54%	2%	44%	○	△	△	△	×	The standard bird control metal attachments seems to be ineffective for large seabird because there were a lot of cases that the standard bird control metal attachments is knocked down. The type of B-2, B-4 was more effective than the type of B-1, B-3.
			B	2	14	100%	−	−	○	△	△	△	×	
			B	3	5	100%	−	−	○	△	△	△	×	
			B	4	13	84%	8%	8%	○	△	△	△	×	
	Standard bird control metal attachments		C	1	1	100%	−	−	○	△	△	○	×	The standard bird control metal attachments seems to be ineffective for large seabird because there were a lot of cases that the standard bird control metal attachments is knocked down.
			C	2	43	90%	5%	5%	○	△	△	○	×	
			C	3	1	100%	−	−	○	△	△	○	×	
Countermeasures against smear caused by birds perching on nearby PV panels	Commercially available plastic attachments	Prop of Topmark	E	1	19	100%	−	−	△	○	×	○	○	The life of the commercially available plastic attachments are about five years.
		Prop of Topmark (all around)	E	4	13	92%	−	8%	△	○	×	○	×	The type of E-1is very effective without all surroundings.
		Handrails/protection frames	F	1	10	60%	20%	20%	△	○	×	○	○	
		Marking system	G	1	1	100%	−	−	△	○	×	○	×	
	Fastening attachments	Prop of Topmark	E	2	8	100%	−	−	○	○	×	×	×	This type was effective equal with the standard bird control metal attachments. It is necessary to narrow the installation interval to achieve an effect and time is required though some is cheap compared with the the commercially available plastic attachments.
		Handrails/protection frames	F	2	25	96%	−	4%	○	○	×	×	×	
		Marking system	G	2	9	67%	33%	−	○	○	×	○	×	
	Metal strings such as wires	Topmark	D	2	139	76%	7%	17%	○	△	△	○	○	
		Prop of Topmark	E	3	35	91%	9%	−	○	△	△	○	○	
	etc.	PET bottle pinwheel	I	1	3	67%	−	33%	○	△	×	×	×	A lot of work
Countermeasures to take using installation methods for PV panels	Perpendicular installation of PV panels	Landing	−	−	5	100%	−	−	○	−	○	○	○	This is limited when there is space that can increase the amount of power generation and the PV

※ Effective : No dropping
A little Effective : Reduction in comparison with the past
Ineffective : No change in comparison with the past