Noninvasive Identification of Individual Polar Bears by Whisker Spot Patterns

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BACKGROUND

Current polar bear identification methods are invasive or involve potentially unreliable scar patterns

Identification methods based on capturing and handling the animals, such as tattooing and ear tagging (Figure 1), are difficult and expensive, and may affect the behavior of the handled bears. Current noninvasive methods are based on scar patterns or other peculiarities (Figure 2), but are unreliable when such marks are absent, which is often the case in females and cubs.

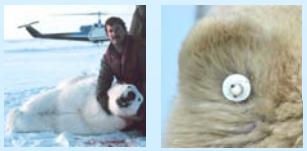

FIGURE 1. Invasive methods involve capturing and handling the bears.

FIGURE 2. Non-invasive methods are based on scar patterns or other peculiarities.

Field observations and photographs of polar bears show that bears may display unique whisker spot patterns

Variation in the whisker spot patterns of polar bears could provide a way to noninvasively and reliably identify individual bears in the field (Figure 3). A formal way of assessing the reliability of such identification method is necessary.

FIGURE 3. Polar bears show variation in their whisker spot patterns.

OBJECTIVE

To determine the reliability of using whisker spot pattern variation to identify individual polar bears

METHODS

We partitioned 50 whisker spot patterns into grid cells and calculated the probability of occurrence of each spot

Digital photographs of 50 polar bears were rotated or flipped so that each bear faced to the right, with the eye and nose positioned horizontally (Figure 4). A grid was superimposed on each image and each cell was given a value of either "present" or "absent" depending on whether the cell contained a whisker spot. Using these cell values from all 50 bears, the probability of occurrence of a spot in each cell was calculated.

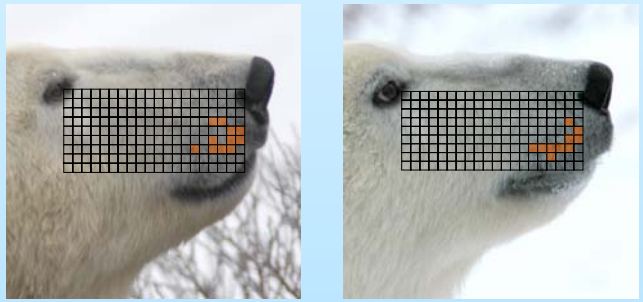

FIGURE 4. Cells colored in orange contain whisker spots, which were used to estimate the probability of occurrence of a spot in each cell.

We calculated the information content of 10,000 spot patterns generated using the probabilities above

Information theory offers a way to measure the complexity of a pattern in terms of its information content. The process for estimating the amount of information required for a "reliable" identification system and the methods for calculating the information content of a pattern are described in Pennycuick (1978). The information required for our identification method was estimated and the information content of 10,000 generated spot patterns was calculated using the equation

$$I = -\log_2 p$$

where I is the information content of the pattern and p is the probability of occurrence of that pattern in the population (where p is obtained by the product of the probabilities of presence or absence of a spot in each cell of that pattern).

RESULTS

Over 99% of all spot patterns analyzed contained at least 13 bits of information required for reliability

In our sample of 50 bears, whisker spots were present in 41 cells (Figure 5). The amount of information required for a spot pattern to be reliable was 13 bits. Over 99% of all spot patterns contained at least 13 bits of information (Figure 6).

	J	K	L	M	N	O	P	Q	R	S
2			0.02							
3								0.04	0.06	0.10
4					0.02		0.06	0.18	0.22	0.64
5				0.04	0.02	0.02	0.02	0.12	0.32	0.58
6				0.04	0.04	0.04	0.16	0.18	0.46	0.70
7				0.08	0.16	0.52	0.48	0.54	0.50	0.42
8	0.02				0.20	0.16	0.30	0.10	0.28	0.08
9					0.02	0.02	0.02	0.04		

FIGURE 5. Probabilities of occurrence of a spot in each cell (for values > 0)

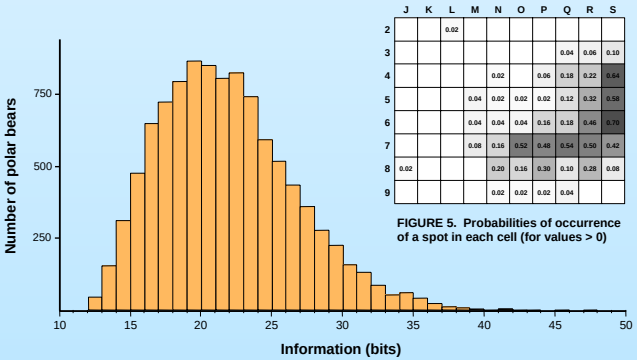

FIGURE 6. Distribution of information content for 10,000 generated spot patterns.

CONCLUSIONS

Individual identification of polar bears based on the variation of whisker spot patterns is reliable

An automated identification system based on the complexity of whisker spot patterns could be implemented to efficiently generate, store, and search a database of polar bears for identification in the field.

ACKNOWLEDGMENTS

We thank Earthwatch Institute for their funding and volunteers. We also thank Cotswold Foundation and Polar Bears International for their additional support. We offer special thanks to Robert and Carolyn Buchanan of PBI.

LITERATURE CITED

Pennycuick, C. J. 1978. Identification using natural markings. In *Animal Markings*: 147-159. B. Stonehouse, editor. London: MacMillan.