Three ways to think about detectability in distance sampling

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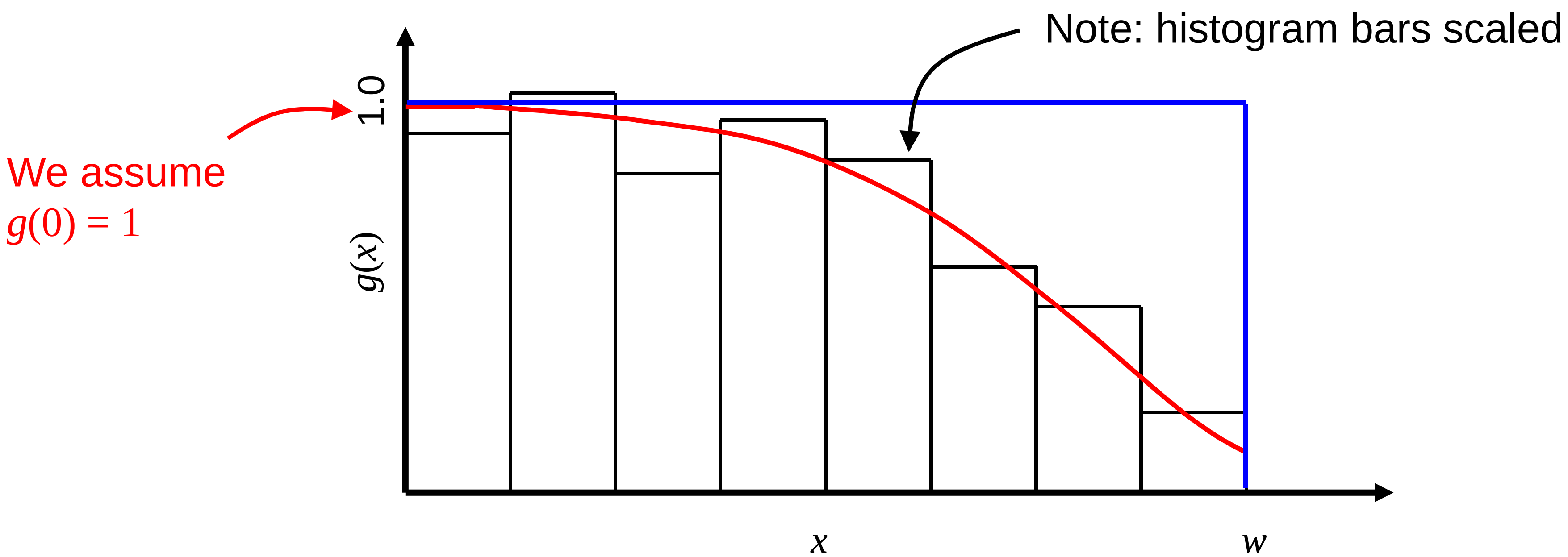
1. The detection function, *g*(*x*)

g(*x*) = probability of detecting an animal, given that it is at distance *x* from the line



$$\hat{P}_a = \frac{\text{area under curve}}{\text{area under rectangle}} = \frac{\int_0^w \hat{g}(x)dx}{1 \times w}$$

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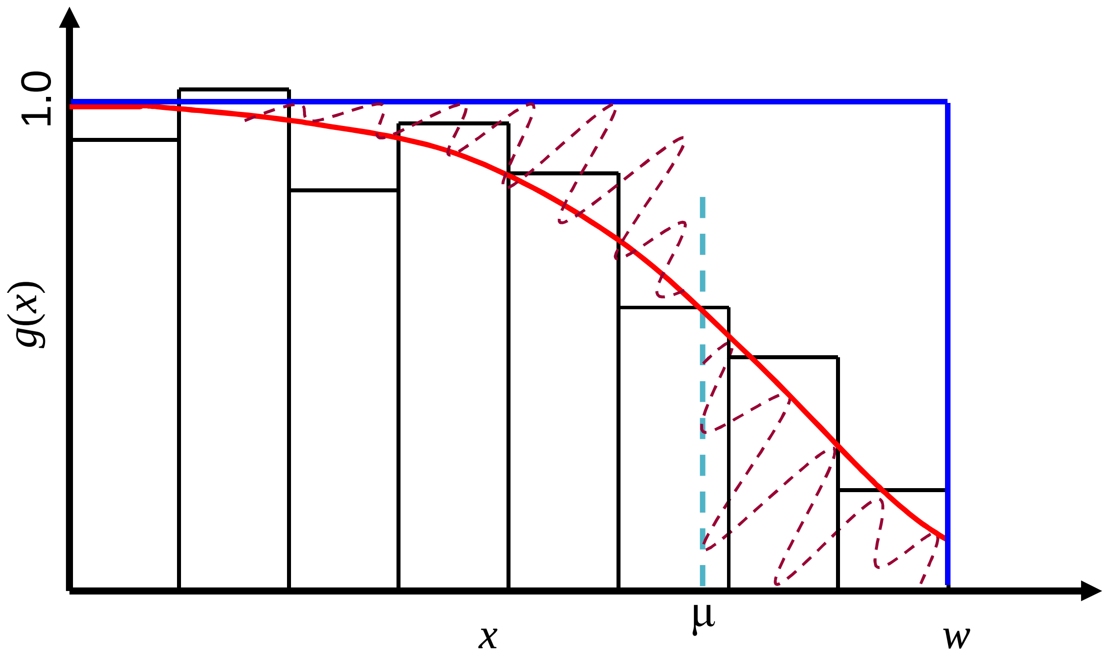
2. Effective strip (half) width, μ

- Instead of a line transect out to w, where proportion P_a objects are seen, think of a strip transect out to some distance μ.



The ESW, μ, is the distance at which as many objects are seen beyond μ as are missed within μ

Line transect out to w

$$\hat{N} = \frac{nA}{2wL\hat{P}_a}$$

Area covered

Strip transect out to μ

$$\hat{N} = \frac{nA}{2\hat{\mu}L}$$

Area effectively covered

$$\hat{P}_a = \frac{\text{area under curve}}{\text{area under rectangle}} = \frac{\int_0^w \hat{g}(x)dx}{w} = \frac{\hat{\mu}}{w}$$

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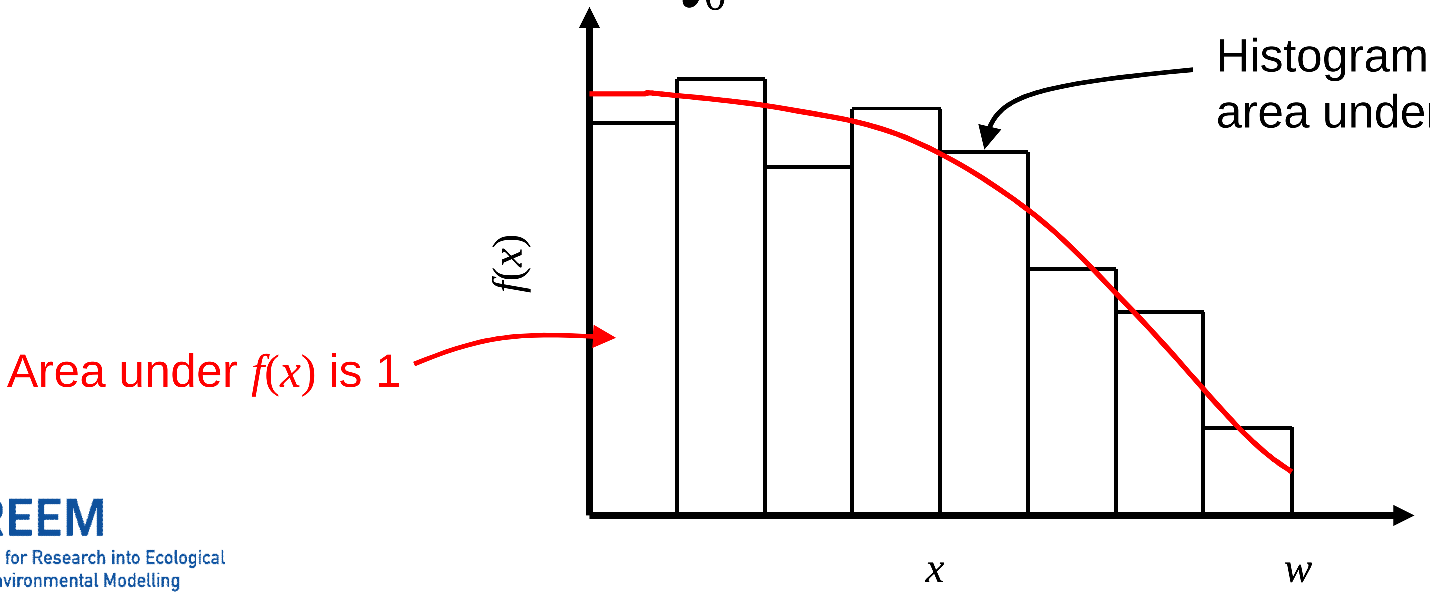
3. The probability density function, $f(x)$

$f(x)dx$ = probability of observing an animal between distance *x and x+dx,* given it was observed somewhere in (0,w)

$f(x)$ is called the probability density function (pdf) of the observed distances

Because observations are between 0 and *w*, the area under $f(x)$ is 1.0

$$\int_0^w f(x)dx = 1$$



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Why is *f*(*x*) useful?

1. Useful for point transects, as it gives the expected distribution of detection distances

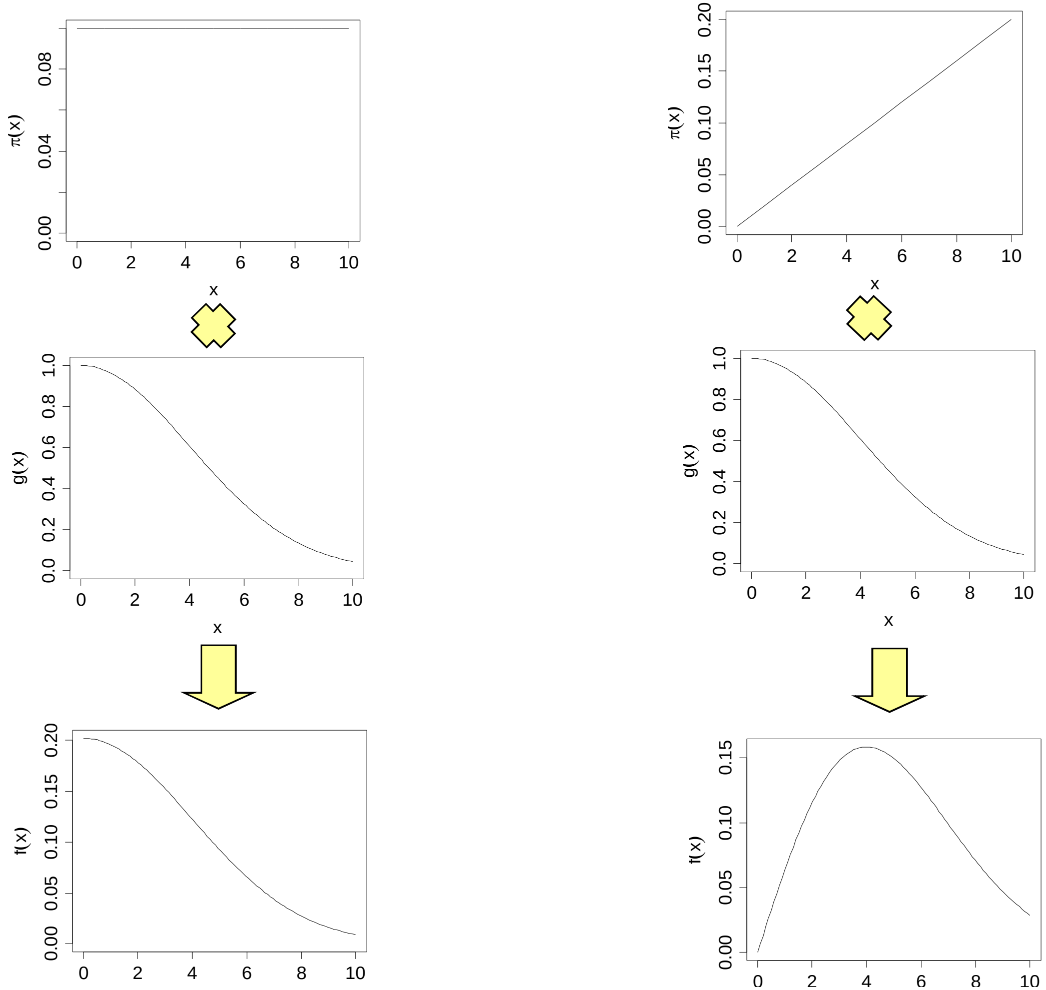
Line transect

Point transect

True distribution of animals

Detection function, $g(x)$

Observed distribution, $f(x)$



see lecture on point transects

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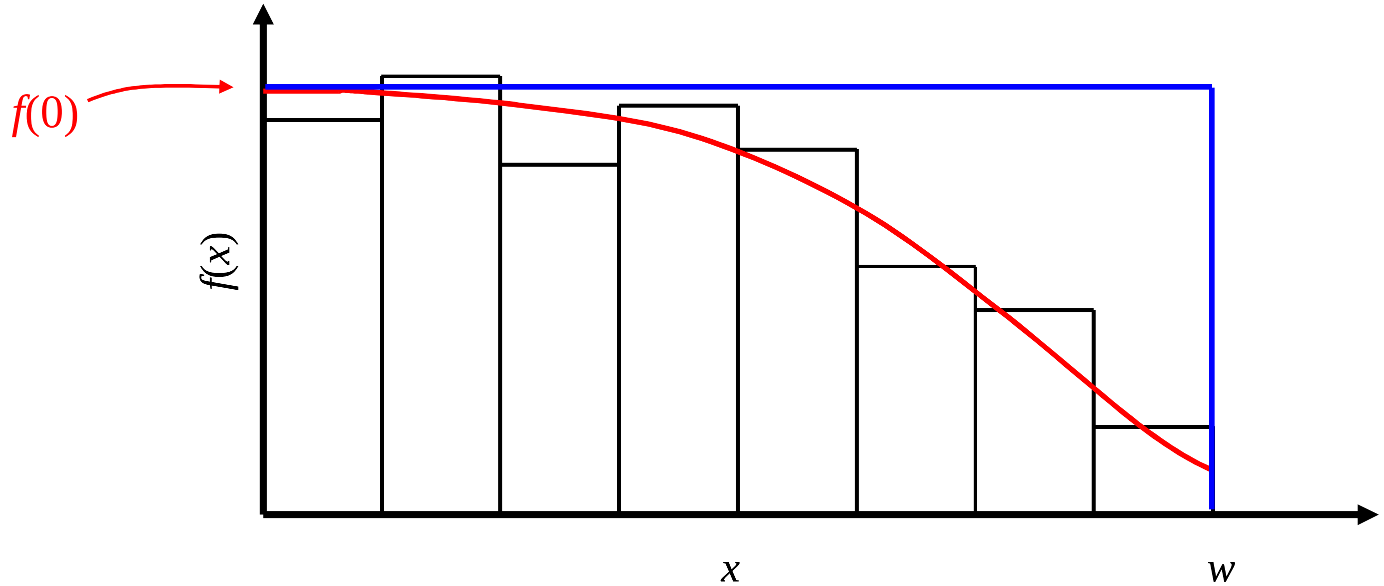
Why is $f(x)$ useful?

2. Gives another way to estimate P_a

Lots of statistical machinery to fit pdfs, so this is the way Distance does it.



Question:
How are $f(0)$ and μ related?

$$\hat{P}_a = \frac{\text{area under curve}}{\text{area under rectangle}} = \frac{1}{\hat{f}(0)w}$$

$$\hat{N} = \frac{nA}{2wL\hat{P}_a} = \frac{nA}{2wL\left(\frac{1}{\hat{f}(0)w}\right)} = \frac{nA\hat{f}(0)}{2L}$$

Formulae – line transects

Three ways to think about line transects

1. Proportion seen or average probability of detection in covered region, P_a

$$\hat{N} = \frac{nA}{2wL\hat{P}_a} \qquad \hat{D} = \frac{n}{2wL\hat{P}_a}$$

2. Effective strip (half-)width, ESW, μ. $\quad P_a = \mu / w$

$$\hat{N} = \frac{nA}{2\hat{\mu}L} \qquad \hat{D} = \frac{n}{2\hat{\mu}L}$$

3. Pdf of observed distances, $f(x)$, evaluated at 0 distance $\quad f(0) = 1/\mu$

$$\hat{N} = \frac{n\hat{f}(0)A}{2L} \qquad \hat{D} = \frac{n\hat{f}(0)}{2L}$$

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Notation – line transects

Known constants and data:

k = number of lines

l_j = length of j^{th} line, j=1,…,k

$L = \Sigma l_j$ = total line length

n = number of animals or clusters detected

x_i = distance of i^{th} detected animal or cluster from the line, i=1,…,n

w = truncation distance for x

A = size of region of interest

a = area of "covered" region = $2wL$

s_i = size of i^{th} detected cluster, i=1,…,n

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Notation – line transects

Parameters and functions:

N = population size / abundance of animals

N_s = abundance of clusters

D = density = animals per unit area = N/A

D_s = density of clusters

$g(x)$ = detection function

$f(x)$ = probability density function (pdf) of observed distances

$f(0)$ = $f(x)$ evaluated at 0 distance

μ = effective strip (half-)width

P_a = probability of detecting an animal or cluster given it is in the covered area a

$E(s)$ = mean size of clusters in the population

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