



1  
00:00:01,000 --> 00:00:07,000  
[music playing]

2  
00:00:17,033 --> 00:00:20,966  
- Welcome to the 2016  
NASA Ames Summer Series.

3  
00:00:22,266 --> 00:00:26,600  
Imagine being on a spacecraft  
exploring the universe

4  
00:00:26,600 --> 00:00:31,233  
and not knowing how your  
life-support system works

5  
00:00:31,233 --> 00:00:34,000  
and its weaknesses.

6  
00:00:34,000 --> 00:00:36,133  
This, for NASA,

7  
00:00:36,133 --> 00:00:39,300  
will be considered  
a very risky mission.

8  
00:00:40,400 --> 00:00:44,300  
Planet Earth is  
such a spacecraft

9  
00:00:44,300 --> 00:00:47,333  
where its surface is  
mostly covered by oceans

10  
00:00:47,333 --> 00:00:50,333  
that we don't fully understand.

11  
00:00:51,633 --> 00:00:53,800  
Today's presentation is entitled

12

00:00:53,800 --> 00:00:55,466

"Sushi and Satellites:

13

00:00:55,466 --> 00:00:58,433

Tracking Predators

Across the Blue Serengeti"

14

00:00:58,433 --> 00:01:02,000

will be given by

Dr. Barbara Block.

15

00:01:02,000 --> 00:01:07,100

Dr. Block is a Charles

and Elizabeth Prothro Professor

16

00:01:07,100 --> 00:01:09,166

in Marine Sciences,

17

00:01:09,166 --> 00:01:13,333

Evolutionary, Cellular,

and Molecular Physiology

18

00:01:13,333 --> 00:01:15,733

at Stanford University.

19

00:01:15,733 --> 00:01:18,933

She is the co-founder

20

00:01:18,933 --> 00:01:20,700

of the Monterey Bay Aquarium

21

00:01:20,700 --> 00:01:23,700

of the Tuna Research

and Conservation Center...

22

00:01:25,600 --> 00:01:28,500

And is a Co-chief Scientist

23

00:01:28,500 --> 00:01:31,500  
for the Tagging  
of Pacific Predators program.

24

00:01:33,400 --> 00:01:37,133  
Dr. Block started her career  
with a Bachelor's of Arts

25

00:01:37,133 --> 00:01:40,733  
at--from  
the University of Vermont

26

00:01:40,733 --> 00:01:44,866  
and began her oceanography  
career with--

27

00:01:44,866 --> 00:01:47,866  
at Woods Hole Institute.

28

00:01:47,866 --> 00:01:50,566  
She earned a PhD  
from Duke University

29

00:01:50,566 --> 00:01:53,133  
and did a postdoc at  
the University of Pennsylvania.

30

00:01:53,133 --> 00:01:56,366  
Please join me  
in welcoming Dr. Block.

31

00:01:56,366 --> 00:01:59,366  
[applause]

32

00:02:02,666 --> 00:02:05,466  
- Well, it's an honor,  
a privilege to be here

33

00:02:05,466 --> 00:02:07,966  
at a NASA facility

giving a talk about Earth.

34

00:02:07,966 --> 00:02:10,066

And I hope that today

35

00:02:10,066 --> 00:02:13,400

I can take you

planetary explorers

36

00:02:13,400 --> 00:02:16,166

back to our planet and give you

a sense of what's happening

37

00:02:16,166 --> 00:02:19,300

in the fluid part of the--

the world, the oceans.

38

00:02:19,300 --> 00:02:23,700

So how many of you,

a personal question, eat sushi?

39

00:02:23,700 --> 00:02:25,433

Everybody.

40

00:02:25,433 --> 00:02:27,566

All right, and who--who's having

a tuna fish sandwich

41

00:02:27,566 --> 00:02:29,500

for lunch today?

42

00:02:29,500 --> 00:02:31,000

Oh, someone in the back,

all right.

43

00:02:31,000 --> 00:02:33,866

So today I hope that

you're going to learn

44

00:02:33,866 --> 00:02:36,233  
more about one of the Olympians  
in the sea,

45  
00:02:36,233 --> 00:02:38,200  
some of the animals we study,

46  
00:02:38,200 --> 00:02:40,100  
the oceans they move through,

47  
00:02:40,100 --> 00:02:42,466  
and then walk away from the talk  
with an understanding

48  
00:02:42,466 --> 00:02:45,233  
of how  
NASA Satellite Oceanography

49  
00:02:45,233 --> 00:02:47,166  
and NOAA Satellite Oceanography

50  
00:02:47,166 --> 00:02:49,933  
provides a lot of the background

51  
00:02:49,933 --> 00:02:53,400  
for how we understand  
how animals are moving

52  
00:02:53,400 --> 00:02:56,100  
across 2/3 of our planet.

53  
00:02:56,100 --> 00:02:59,333  
So the challenge,  
if I take you back to Earth,

54  
00:02:59,333 --> 00:03:03,733  
and we watch the spinning  
SeaWiFS view of the planet,

55

00:03:03,733 --> 00:03:08,133  
is I'm going to argue today  
that significant portions

56

00:03:08,133 --> 00:03:11,266  
of our federal budget should be  
spent on our planet

57

00:03:11,266 --> 00:03:13,566  
because we really don't  
understand 2/3 of it

58

00:03:13,566 --> 00:03:14,666  
all right?

59

00:03:14,666 --> 00:03:16,533  
So our view has changed  
radically

60

00:03:16,533 --> 00:03:18,600  
since we've had  
Earth-orbiting satellites.

61

00:03:18,600 --> 00:03:20,633  
We see the seasonal changes,

62

00:03:20,633 --> 00:03:24,533  
but the challenge for  
the terrestrial vertebrate,

63

00:03:24,533 --> 00:03:27,133  
the primate called man or woman,

64

00:03:27,133 --> 00:03:30,033  
is we have a hard time  
understanding

65

00:03:30,033 --> 00:03:32,900  
the mathematics,  
the fluid dynamics,

66

00:03:32,900 --> 00:03:34,733  
and the challenges

67

00:03:34,733 --> 00:03:37,366  
of modeling organisms

68

00:03:37,366 --> 00:03:39,400  
as they live in  
this fluid realm

69

00:03:39,400 --> 00:03:41,000  
that's not very transparent.

70

00:03:41,000 --> 00:03:44,066  
And to this day, we're just  
beginning, all right?

71

00:03:44,066 --> 00:03:45,800  
We haven't been here very long

72

00:03:45,800 --> 00:03:47,733  
and we're just trying  
to figure out, really,

73

00:03:47,733 --> 00:03:48,766  
how this planet works.

74

00:03:48,766 --> 00:03:51,100  
Now, put in context what I do.

75

00:03:51,100 --> 00:03:53,133  
I study the Olympian of the sea,

76

00:03:53,133 --> 00:03:55,333  
the giant bluefin tuna  
or a white shark,

77

00:03:55,333 --> 00:03:58,200  
and as they slip  
beneath the waves,

78

00:03:58,200 --> 00:04:02,433  
just like a whale, everything  
becomes nontransparent

79

00:04:02,433 --> 00:04:04,600  
and radio signals don't work.

80

00:04:04,600 --> 00:04:06,766  
So how do you study animals

81

00:04:06,766 --> 00:04:09,333  
who move across  
such large realms,

82

00:04:09,333 --> 00:04:11,166  
and what can it teach us

83

00:04:11,166 --> 00:04:13,266  
if we're trying to go  
to other galaxies

84

00:04:13,266 --> 00:04:15,833  
and study other places?

85

00:04:15,833 --> 00:04:18,933  
I've always enjoyed this view,  
this NASA view of our planet.

86

00:04:18,933 --> 00:04:21,866  
I used it many times  
in a program called

87

00:04:21,866 --> 00:04:23,200  
the Census of Marine Life.

88

00:04:23,200 --> 00:04:27,833

Perhaps our globe's largest  
program ever

89

00:04:27,833 --> 00:04:30,233

in the last decade

90

00:04:30,233 --> 00:04:33,100

to understand the biodiversity  
of our planet.

91

00:04:33,100 --> 00:04:35,900

I was fortunate enough  
to lead one of the projects

92

00:04:35,900 --> 00:04:38,033

called TOPP,

93

00:04:38,033 --> 00:04:42,166

and this enabled us to basically  
study large predators

94

00:04:42,166 --> 00:04:44,966

as they moved across  
the Pacific Ocean,

95

00:04:44,966 --> 00:04:46,700

the largest ocean on the planet.

96

00:04:46,700 --> 00:04:49,333

So the dots that you'll see on  
maps today

97

00:04:49,333 --> 00:04:50,633

represent where animals go.

98

00:04:50,633 --> 00:04:53,500

And part of the lesson today is  
how is it that

99

00:04:53,500 --> 00:04:56,500

we build the engineering  
devices that enable us

100

00:04:56,500 --> 00:04:59,300

to see where the fastest  
animals in the ocean go

101

00:04:59,300 --> 00:05:01,933

beneath the waves

102

00:05:01,933 --> 00:05:03,700

where you can't use  
radio signals?

103

00:05:03,700 --> 00:05:04,833

And I want you to be thinking  
about that

104

00:05:04,833 --> 00:05:08,733

because the challenge is great.

105

00:05:08,733 --> 00:05:11,833

So up until recently,  
our view of our own planet--

106

00:05:11,833 --> 00:05:16,000

coming from this institution  
too--was one in which

107

00:05:16,000 --> 00:05:18,400

all we could do  
was see the surface.

108

00:05:18,400 --> 00:05:21,800

We didn't really see  
beneath the sea,

109

00:05:21,800 --> 00:05:24,900

and the level of spending that  
we do to understand our planet

110

00:05:24,900 --> 00:05:27,833

isn't high enough  
to actually ensure

111

00:05:27,833 --> 00:05:30,166

that the next generation of  
engineering tools,

112

00:05:30,166 --> 00:05:33,266

the next generation of  
computational tools,

113

00:05:33,266 --> 00:05:35,200

are getting into our ocean  
quick enough

114

00:05:35,200 --> 00:05:38,433

so we solve the major questions  
of our time.

115

00:05:38,433 --> 00:05:41,333

What's the ocean  
atmosphere interaction

116

00:05:41,333 --> 00:05:44,166

and how is it creating

117

00:05:44,166 --> 00:05:48,333

and impacting the change  
that we call climate?

118

00:05:48,333 --> 00:05:51,233

We have to separate  
the variability

119

00:05:51,233 --> 00:05:54,900

from the overall change

that we know is occurring

120

00:05:54,900 --> 00:05:56,266  
on this planet,

121

00:05:56,266 --> 00:05:59,600  
and we haven't yet  
really spent the time,

122

00:05:59,600 --> 00:06:01,533  
created the mathematics,

123

00:06:01,533 --> 00:06:03,500  
created the tools  
that are allowing us

124

00:06:03,500 --> 00:06:06,966  
to understand 2/3  
of our planet Earth.

125

00:06:06,966 --> 00:06:09,766  
So then add to that  
that researchers like myself

126

00:06:09,766 --> 00:06:12,633  
want to study the animals  
who live in the planet,

127

00:06:12,633 --> 00:06:14,266  
beneath the sea  
that's not transparent,

128

00:06:14,266 --> 00:06:17,200  
and try to figure out  
how they work

129

00:06:17,200 --> 00:06:19,666  
before it's too late  
for many of these populations

130  
00:06:19,666 --> 00:06:23,100  
because our appetite across  
the globe for sushi

131  
00:06:23,100 --> 00:06:26,400  
is actually threatening  
many populations of animals,

132  
00:06:26,400 --> 00:06:28,533  
such as tunas, in the sea.

133  
00:06:28,533 --> 00:06:31,966  
So I'd argue here at NASA

134  
00:06:31,966 --> 00:06:33,466  
that the most important thing  
we do

135  
00:06:33,466 --> 00:06:35,333  
in the next 100 years,

136  
00:06:35,333 --> 00:06:38,100  
the most important thing we're  
doing in the next 50 years

137  
00:06:38,100 --> 00:06:41,100  
is using some of the technology  
you're creating

138  
00:06:41,100 --> 00:06:44,466  
to go to other planets

139  
00:06:44,466 --> 00:06:45,933  
right here on Earth

140  
00:06:45,933 --> 00:06:47,600  
so that we can  
better understand

141  
00:06:47,600 --> 00:06:49,600  
how is it that we will know

142  
00:06:49,600 --> 00:06:51,800  
when our seascapes  
are changing,

143  
00:06:51,800 --> 00:06:54,066  
and what is it we should know

144  
00:06:54,066 --> 00:06:57,266  
to prevent having any big  
surprises happen

145  
00:06:57,266 --> 00:06:59,000  
on our planet?

146  
00:06:59,000 --> 00:07:01,566  
And we're going to tell you  
today, as oceanographers,

147  
00:07:01,566 --> 00:07:04,300  
it's not easy,

148  
00:07:04,300 --> 00:07:07,300  
and it requires  
a national commitment

149  
00:07:07,300 --> 00:07:10,533  
to oceans  
that we haven't yet seen.

150  
00:07:12,066 --> 00:07:14,200  
So I study big tunas.

151  
00:07:14,200 --> 00:07:17,333  
I became fascinated with tunas  
at the age of an intern

152  
00:07:17,333 --> 00:07:19,000  
in this room,

153  
00:07:19,000 --> 00:07:22,633  
a person who basically started  
as an intern

154  
00:07:22,633 --> 00:07:25,533  
in a laboratory at Woods Hole  
Oceanographic Institution

155  
00:07:25,533 --> 00:07:28,233  
and was fascinated  
because these are

156  
00:07:28,233 --> 00:07:30,966  
one of the few warm fish  
in the sea.

157  
00:07:30,966 --> 00:07:33,600  
They're endothermic,  
warm-bodied like we are.

158  
00:07:33,600 --> 00:07:35,366  
They're powerful animals

159  
00:07:35,366 --> 00:07:38,233  
that if you catch one  
at the end of a hook and line,

160  
00:07:38,233 --> 00:07:42,000  
you may be battling it  
for hours.

161  
00:07:42,000 --> 00:07:44,200  
So these Olympians are known  
across the planet

162  
00:07:44,200 --> 00:07:46,400

to everybody else as sushi,  
all right?

163  
00:07:46,400 --> 00:07:49,700  
And the next time you have  
your sushi dinner or lunch,

164  
00:07:49,700 --> 00:07:52,833  
I want you to take a good look  
at that piece of red muscle,

165  
00:07:52,833 --> 00:07:55,000  
which is really white muscle,

166  
00:07:55,000 --> 00:07:57,800  
it looks red, and ask yourself,  
where did it come from?

167  
00:07:57,800 --> 00:08:00,300  
And then hopefully you'll share  
one of the lessons perhaps

168  
00:08:00,300 --> 00:08:02,266  
that you'll learn today.

169  
00:08:02,266 --> 00:08:06,300  
We've made it easy  
for all of you to see tunas

170  
00:08:06,300 --> 00:08:08,100  
just a hundred miles  
down the road

171  
00:08:08,100 --> 00:08:09,666  
at the Monterey Bay Aquarium,

172  
00:08:09,666 --> 00:08:14,866  
where behind a wall  
of very thick acrylic...

173

00:08:14,866 --> 00:08:17,400

we've got one of  
the largest displays

174

00:08:17,400 --> 00:08:20,166

of bluefin tuna  
from the Pacific,

175

00:08:20,166 --> 00:08:22,466

an animal that's now  
being proposed

176

00:08:22,466 --> 00:08:25,533

for an ESA, an Endangered  
Species Act, listing

177

00:08:25,533 --> 00:08:28,333

here in North America.

178

00:08:28,333 --> 00:08:30,433

We've also had, in the past--  
[clears throat]

179

00:08:30,433 --> 00:08:32,033

Excuse me--

180

00:08:32,033 --> 00:08:33,600

white sharks.

181

00:08:33,600 --> 00:08:35,500

We're the only aquarium

182

00:08:35,500 --> 00:08:37,766

that's been able to keep alive

183

00:08:37,766 --> 00:08:40,000

young white sharks  
in captivity.

184

00:08:40,000 --> 00:08:42,800

So what's the importance of  
having tunas and white sharks

185

00:08:42,800 --> 00:08:44,700

behind glass?

186

00:08:44,700 --> 00:08:48,066

Well, the first thing is if you  
look at this animal moving

187

00:08:48,066 --> 00:08:50,233

and perhaps... can we  
bring the lights down at all

188

00:08:50,233 --> 00:08:54,300

so that we can see the ocean  
a little better?

189

00:08:54,300 --> 00:08:56,866

You'd be interested to know  
that from a Navy perspective,

190

00:08:56,866 --> 00:08:58,500

tunas are quite interesting.

191

00:08:58,500 --> 00:09:01,833

They're one of the most  
fusiform shapes in the sea.

192

00:09:01,833 --> 00:09:03,266

They have the lowest  
coefficient of drag

193

00:09:03,266 --> 00:09:05,200

that you'll ever find  
in nature.

194

00:09:05,200 --> 00:09:07,233

And we're interested in how  
everything from their skin

195

00:09:07,233 --> 00:09:09,233  
to their biomechanics

196

00:09:09,233 --> 00:09:11,766  
is uniquely formed

197

00:09:11,766 --> 00:09:14,066  
morphologically  
and physiologically

198

00:09:14,066 --> 00:09:17,266  
to help enhance these animals  
as they cross the oceans.

199

00:09:17,266 --> 00:09:19,666  
We only just, in the past year,

200

00:09:19,666 --> 00:09:24,000  
were able to put a camera that,  
working with a company,

201

00:09:24,000 --> 00:09:27,800  
we've helped to engineer to do  
exactly what we want on a tuna

202

00:09:27,800 --> 00:09:30,566  
so that we can watch  
the flip of its tail

203

00:09:30,566 --> 00:09:32,400  
as it goes behind the sea.

204

00:09:32,400 --> 00:09:36,000  
How this animal creates  
vorticity may be a secret

205

00:09:36,000 --> 00:09:38,700  
of how the most efficient  
machines on the planet,

206  
00:09:38,700 --> 00:09:41,333  
if they were in the ocean,  
should be moving.

207  
00:09:41,333 --> 00:09:44,133  
All right, these are animals  
who cross tens of thousands

208  
00:09:44,133 --> 00:09:47,966  
of nautical miles in a year

209  
00:09:47,966 --> 00:09:49,800  
in the ocean.

210  
00:09:49,800 --> 00:09:52,000  
So my real fascination is

211  
00:09:52,000 --> 00:09:54,633  
what makes the Olympian  
so unique, the tuna?

212  
00:09:54,633 --> 00:09:57,200  
I don't want to give  
that lecture today

213  
00:09:57,200 --> 00:09:59,200  
but I've just left you  
with a few thoughts.

214  
00:09:59,200 --> 00:10:01,866  
They're actually moving  
like a kangaroo.

215  
00:10:01,866 --> 00:10:04,366  
A kangaroo bounces,  
stores elastic energy,

216

00:10:04,366 --> 00:10:08,800

and then hops again at an almost  
free energetic cost.

217

00:10:08,800 --> 00:10:12,266

A tuna bends its tail,  
stretching elastic tendons,

218

00:10:12,266 --> 00:10:13,900

as we've been learning,

219

00:10:13,900 --> 00:10:16,266

and actually can bring its tail  
back to its center position

220

00:10:16,266 --> 00:10:20,133

without much muscular energy  
being utilized.

221

00:10:20,133 --> 00:10:22,800

If we could make  
an autonomous vehicle

222

00:10:22,800 --> 00:10:25,700

that's using  
the biomechanics of a tuna,

223

00:10:25,700 --> 00:10:28,300

we might be able to go places  
further.

224

00:10:28,300 --> 00:10:30,100

These animals are powered,

225

00:10:30,100 --> 00:10:32,933

as that infrared image shows you  
its heat,

226

00:10:32,933 --> 00:10:34,866  
by warm muscles,

227

00:10:34,866 --> 00:10:37,500  
and it helps us understand  
the mechanical advantages

228

00:10:37,500 --> 00:10:39,666  
really of being warm.

229

00:10:39,666 --> 00:10:42,466  
But when it comes to  
understanding a tuna's journey

230

00:10:42,466 --> 00:10:44,800  
beneath the sea, as I've said,  
they're difficult to study,

231

00:10:44,800 --> 00:10:47,266  
that's why we know so little  
up until recently.

232

00:10:47,266 --> 00:10:48,633  
They're highly migratory.

233

00:10:48,633 --> 00:10:52,833  
A single tuna will be born  
in the seas off Japan,

234

00:10:52,833 --> 00:10:56,333  
in its lifetime  
swim over to Mexico,

235

00:10:56,333 --> 00:10:59,033  
spend four years  
here in California waters

236

00:10:59,033 --> 00:11:02,100  
swimming north and south  
between California and Mexico,

237

00:11:02,100 --> 00:11:05,966

go back to Japan, and then take  
a post-spawning migration

238

00:11:05,966 --> 00:11:07,433

down to New Zealand  
and come back.

239

00:11:07,433 --> 00:11:11,433

Largest life history  
of any fish we know in the sea.

240

00:11:11,433 --> 00:11:13,433

How can we study that?

241

00:11:13,433 --> 00:11:15,700

So in our field,  
there's been a push

242

00:11:15,700 --> 00:11:18,966

towards small,  
miniature electronic devices

243

00:11:18,966 --> 00:11:21,266

that we can put on the animals.

244

00:11:21,266 --> 00:11:24,500

There's been a push towards  
using genomics

245

00:11:24,500 --> 00:11:27,366

and chemical markers, these  
would be elements in the animal

246

00:11:27,366 --> 00:11:28,733

that tell us where it's been.

247

00:11:28,733 --> 00:11:30,866

Has it been off the waters  
of Fukushima?

248

00:11:30,866 --> 00:11:33,566

And then come on over,  
we can actually measure that,

249

00:11:33,566 --> 00:11:36,833

and then we can begin to put  
together the migrations.

250

00:11:36,833 --> 00:11:38,066

And there's a lot of  
novel techniques

251

00:11:38,066 --> 00:11:40,300

in the last few years  
that have developed,

252

00:11:40,300 --> 00:11:42,133

but overall, these fields  
aren't well-funded,

253

00:11:42,133 --> 00:11:44,433

and so knowing  
simple questions,

254

00:11:44,433 --> 00:11:46,766

like how many white sharks  
there are in the sea,

255

00:11:46,766 --> 00:11:48,766

how many are there  
off California,

256

00:11:48,766 --> 00:11:51,933

how big is the spawning  
population of bluefin

257

00:11:51,933 --> 00:11:53,866

left in the Pacific Ocean?

258

00:11:53,866 --> 00:11:56,100

These are not  
easy-to-answer questions.

259

00:11:56,100 --> 00:11:58,500

They require  
interdisciplinary science

260

00:11:58,500 --> 00:12:01,366

of ocean science,  
satellite oceanography,

261

00:12:01,366 --> 00:12:05,300

electronic tagging,  
and computational mathematics

262

00:12:05,300 --> 00:12:08,300

to help put together models  
of how many animals there are.

263

00:12:09,500 --> 00:12:11,866

So certainly,  
you won't forget this,

264

00:12:11,866 --> 00:12:14,466

that the next time you go over  
the Golden Gate Bridge,

265

00:12:14,466 --> 00:12:18,366

let me be the first to tell you  
that our research has shown

266

00:12:18,366 --> 00:12:21,400

that white sharks  
are crossing beneath you

267

00:12:21,400 --> 00:12:24,833

and moving in to the

San Francisco Bay, all right?

268

00:12:24,833 --> 00:12:28,300

So we know this primarily  
from electronic tags,

269

00:12:28,300 --> 00:12:31,266

but when you see across  
the bridge into the surface,

270

00:12:31,266 --> 00:12:33,100

you hardly know what's  
happening beneath you.

271

00:12:33,100 --> 00:12:35,200

We know from  
electronic tags,

272

00:12:35,200 --> 00:12:37,100

and I'm just giving  
an overview at this point,

273

00:12:37,100 --> 00:12:39,233

that we can see  
in the white dots

274

00:12:39,233 --> 00:12:41,766

from satellite tags--I'll  
explain how they work shortly--

275

00:12:41,766 --> 00:12:44,500

we can see where  
a white shark goes

276

00:12:44,500 --> 00:12:46,866

and the only boundaries  
for its protection

277

00:12:46,866 --> 00:12:49,233

are the green areas

barely visible on the map.

278

00:12:49,233 --> 00:12:52,333

Those would be sanctuaries  
and reserves.

279

00:12:52,333 --> 00:12:55,233

And you're looking at 1/3,  
if you will,

280

00:12:55,233 --> 00:12:58,200

of the Pacific there,  
from our shores to Hawaii.

281

00:12:58,200 --> 00:13:01,133

And the black areas are EEZs.

282

00:13:01,133 --> 00:13:03,600

So a white shark,  
if we're asking,

283

00:13:03,600 --> 00:13:06,533

is this an animal  
that has any protection?

284

00:13:06,533 --> 00:13:09,000

It's an animal that's listed at  
the highest levels

285

00:13:09,000 --> 00:13:12,066

of being concerned.

286

00:13:12,066 --> 00:13:14,033

It's really got  
this huge open space

287

00:13:14,033 --> 00:13:15,600

where it roams.

288

00:13:15,600 --> 00:13:19,500

And these open spaces  
we've only just been studying.

289

00:13:19,500 --> 00:13:21,766

So this is tracks  
from our satellite tags

290

00:13:21,766 --> 00:13:24,966

I'll be talking about in which  
a white shark is moving

291

00:13:24,966 --> 00:13:27,366

from California  
to a center place

292

00:13:27,366 --> 00:13:30,400

halfway between Hawaii  
and California,

293

00:13:30,400 --> 00:13:32,200

a place we call  
the White Shark Café.

294

00:13:32,200 --> 00:13:34,633

And these places  
weren't even known

295

00:13:34,633 --> 00:13:36,733

less than a decade ago.

296

00:13:36,733 --> 00:13:38,900

All of the North American  
white sharks

297

00:13:38,900 --> 00:13:41,333

gather in a single place,

298

00:13:41,333 --> 00:13:44,166

and this single place

we've never been to

299

00:13:44,166 --> 00:13:45,866

but we know it exists,

300

00:13:45,866 --> 00:13:48,533

and we want to know why.

301

00:13:48,533 --> 00:13:50,700

We want to know why

because that's a picture

302

00:13:50,700 --> 00:13:52,566

that has been generated

303

00:13:52,566 --> 00:13:55,133

through listening to

the radio signals of AIS,

304

00:13:55,133 --> 00:13:59,233

that's what we use on ships

to avoid collisions.

305

00:13:59,233 --> 00:14:02,866

Our collaborators at Google

and SkyTruth

306

00:14:02,866 --> 00:14:05,666

have created a program called

307

00:14:05,666 --> 00:14:07,400

Global FishWatch.

308

00:14:07,400 --> 00:14:09,200

That's human beings.

We're predators.

309

00:14:09,200 --> 00:14:10,533

That's where we are.

310

00:14:10,533 --> 00:14:13,766

This is just the fishing  
human beings with AIS.

311

00:14:13,766 --> 00:14:16,300

And right in the café  
we've got an area

312

00:14:16,300 --> 00:14:19,733

that humans are actually  
interacting within.

313

00:14:19,733 --> 00:14:21,466

So we're concerned that  
no matter what we do

314

00:14:21,466 --> 00:14:23,533

for white sharks on our coast,

315

00:14:23,533 --> 00:14:26,966

if we have this  
human predation situation,

316

00:14:26,966 --> 00:14:29,400

this is all sort of the wild  
west of where humans are

317

00:14:29,400 --> 00:14:30,666

on our planet,

318

00:14:30,666 --> 00:14:34,066

we might have a problem  
conserving these animals

319

00:14:34,066 --> 00:14:37,066

if we can't actually  
keep track of who's there.

320

00:14:38,533 --> 00:14:42,066

I also do what some of you do  
here at NASA at Ames,

321

00:14:42,066 --> 00:14:45,033

I'm actually a card-carrying  
animal physiologist.

322

00:14:45,033 --> 00:14:47,200

That's what I teach at Stanford.

323

00:14:47,200 --> 00:14:49,366

I'm interested in how  
an organism works

324

00:14:49,366 --> 00:14:52,100

from its genes  
to its environment.

325

00:14:52,100 --> 00:14:54,900

I'm interested primarily  
in the cardiac physiology

326

00:14:54,900 --> 00:14:57,966

of how the Olympic athlete,  
the tuna, works.

327

00:14:57,966 --> 00:15:01,133

I think as a nation we're not  
really considering enough,

328

00:15:01,133 --> 00:15:04,833

if we really are headed towards  
this warming world,

329

00:15:04,833 --> 00:15:09,000

what will be the impact  
on mammals such as ourselves?

330

00:15:09,000 --> 00:15:11,466

I study what the impact is  
on fish,

331

00:15:11,466 --> 00:15:14,800

and what we're learning is that  
the atrium of our hearts

332

00:15:14,800 --> 00:15:18,566

is actually  
a very sensitive organ.

333

00:15:18,566 --> 00:15:21,533

All right, so what we can learn  
from studying fish physiology

334

00:15:21,533 --> 00:15:24,500

can teach us about what's  
happening in the world around us

335

00:15:24,500 --> 00:15:27,233

of humans, of polar bears,

336

00:15:27,233 --> 00:15:31,100

all from studying  
an Olympic heart of a tuna.

337

00:15:31,100 --> 00:15:34,600

We do this by having  
unusual facilities in Monterey

338

00:15:34,600 --> 00:15:36,300

in back of  
the Monterey Bay Aquarium.

339

00:15:36,300 --> 00:15:39,733

At Stanford University,  
we've got treadmills

340

00:15:39,733 --> 00:15:41,500

that allows us to put fish

341

00:15:41,500 --> 00:15:45,233  
inside the flume  
and ask the question,

342

00:15:45,233 --> 00:15:47,266  
what's it like to swim  
to Japan?

343

00:15:47,266 --> 00:15:50,700  
And we can find out  
how these animals operate.

344

00:15:50,700 --> 00:15:53,100  
We can work with our friends  
from ONR,

345

00:15:53,100 --> 00:15:56,033  
instrument the animals  
all along their bodies

346

00:15:56,033 --> 00:15:58,333  
or make models  
and instrument them,

347

00:15:58,333 --> 00:16:00,833  
and try to learn the secrets  
of how, when they swim,

348

00:16:00,833 --> 00:16:04,100  
they actually keep flow laminar  
across most of their body

349

00:16:04,100 --> 00:16:06,500  
in a way that's  
extraordinarily unique.

350

00:16:06,500 --> 00:16:10,266  
And then we can build AUVs  
or automated vehicles that--

351

00:16:10,266 --> 00:16:14,700  
that use these principles  
in the mechanical design.

352

00:16:14,700 --> 00:16:17,900  
And then most important,  
even for a mission to Mars,

353

00:16:17,900 --> 00:16:19,866  
we have to,  
as physiologists,

354

00:16:19,866 --> 00:16:21,233  
work together to understand

355

00:16:21,233 --> 00:16:23,800  
what is resilience  
in the physiological system?

356

00:16:23,800 --> 00:16:26,500  
What is it that we need to be  
paying attention to

357

00:16:26,500 --> 00:16:29,066  
in a warming sea  
or a cooling sea?

358

00:16:29,066 --> 00:16:32,033  
What do you need to be  
paying attention to

359

00:16:32,033 --> 00:16:34,866  
for an organism that has to  
travel a long distance

360

00:16:34,866 --> 00:16:37,433  
without much gravity?

361

00:16:37,433 --> 00:16:40,166  
And we are at the cutting edge

362  
00:16:40,166 --> 00:16:42,866  
of trying to figure out what  
are the tools of genomics

363  
00:16:42,866 --> 00:16:45,333  
that can teach us  
the clear signals

364  
00:16:45,333 --> 00:16:47,966  
we should be watching for  
in our organelles

365  
00:16:47,966 --> 00:16:51,833  
as we look for these changes  
that we call adaptation

366  
00:16:51,833 --> 00:16:55,000  
or resilience to warming seas.

367  
00:16:55,000 --> 00:16:57,500  
It's hard to focus on  
the individual organism

368  
00:16:57,500 --> 00:17:00,133  
when we really have  
this collective planet,

369  
00:17:00,133 --> 00:17:02,166  
this planet that all of us  
in this room

370  
00:17:02,166 --> 00:17:03,166  
need to be thinking about

371  
00:17:03,166 --> 00:17:05,033  
which is undergoing

372

00:17:05,033 --> 00:17:07,600

extraordinary  
physiological changes,

373

00:17:07,600 --> 00:17:10,800

but we've only just begun to  
develop the monitoring system

374

00:17:10,800 --> 00:17:14,200

to keep our eyes  
on what's happening.

375

00:17:14,200 --> 00:17:16,733

This ocean is warming

376

00:17:16,733 --> 00:17:18,200

along with the planet.

377

00:17:18,200 --> 00:17:20,600

Perhaps less understood

378

00:17:20,600 --> 00:17:23,366

is the fact it's deoxygenating.

379

00:17:23,366 --> 00:17:27,100

This ocean that gave rise  
to all of life on this planet

380

00:17:27,100 --> 00:17:31,000

is losing its oxygen as  
the physics of warming happens.

381

00:17:31,000 --> 00:17:34,800

And then the most concerning  
aspect of the oceans

382

00:17:34,800 --> 00:17:38,200

is as it buffers this planet,  
the CO<sub>2</sub> that's being absorbed,

383

00:17:38,200 --> 00:17:41,366  
we're getting an increase  
of acidity.

384

00:17:41,366 --> 00:17:44,266  
The physiology of Earth

385

00:17:44,266 --> 00:17:47,666  
may be the most important thing  
that we're studying right now,

386

00:17:47,666 --> 00:17:49,800  
and yet the NASA budget  
probably doesn't have

387

00:17:49,800 --> 00:17:52,533  
a whole lot in it for  
this particular enterprise.

388

00:17:52,533 --> 00:17:54,300  
All right?

389

00:17:54,300 --> 00:17:56,333  
This is really our future,

390

00:17:56,333 --> 00:17:58,933  
this planet.

391

00:17:58,933 --> 00:18:02,733  
Our planet is a planet in which  
climate change is real

392

00:18:02,733 --> 00:18:05,600  
and it's happening and we can  
measure it in the seas.

393

00:18:05,600 --> 00:18:08,333  
And our planet is a planet

in which humans

394

00:18:08,333 --> 00:18:12,033  
across this planet are taking  
the sharks and the tunas,

395

00:18:12,033 --> 00:18:15,500  
all of the large predators,  
out at an alarming rate

396

00:18:15,500 --> 00:18:18,566  
and despite enormous efforts  
of good management

397

00:18:18,566 --> 00:18:20,233  
here in our nation,

398

00:18:20,233 --> 00:18:22,433  
we still have to actually  
deal with the fact

399

00:18:22,433 --> 00:18:26,266  
that much of the problems  
are in unregulated seas.

400

00:18:26,266 --> 00:18:28,000  
So predators are in decline

401

00:18:28,000 --> 00:18:30,600  
and when you put a long line in  
to capture a tuna

402

00:18:30,600 --> 00:18:33,733  
or a shark, it often captures  
a leatherback--

403

00:18:33,733 --> 00:18:36,633  
every species of turtle  
on this planet

404

00:18:36,633 --> 00:18:38,833

that's a marine turtle  
is endangered--

405

00:18:38,833 --> 00:18:41,966

an albatross,  
or many other species.

406

00:18:41,966 --> 00:18:44,400

This happens because of  
our appetite on this planet

407

00:18:44,400 --> 00:18:46,533

for sushi and tuna, all right?

408

00:18:46,533 --> 00:18:49,333

We're at a point where there's  
7 billion people

409

00:18:49,333 --> 00:18:51,566

headed to potentially 8 or 9,

410

00:18:51,566 --> 00:18:53,600

and now that tuna stocks  
are down,

411

00:18:53,600 --> 00:18:56,766

sharks are becoming  
a targeted species.

412

00:18:56,766 --> 00:19:00,266

I like to remind myself that  
all of this happened

413

00:19:00,266 --> 00:19:01,300

in my lifetime.

414

00:19:01,300 --> 00:19:03,766

When I was born

415

00:19:03,766 --> 00:19:05,800  
and the Apollo missions  
were happening,

416

00:19:05,800 --> 00:19:08,033  
our oceans were virgin places,

417

00:19:08,033 --> 00:19:10,566  
barely understood.

418

00:19:10,566 --> 00:19:13,166  
I was drawn into  
Woods Hole Oceanographic,

419

00:19:13,166 --> 00:19:15,100  
like many of you to exploration,

420

00:19:15,100 --> 00:19:18,266  
because of the enormous  
excitement around discovery

421

00:19:18,266 --> 00:19:19,833  
of the vents.

422

00:19:19,833 --> 00:19:24,366  
And the 50 years of this  
lifetime my own,

423

00:19:24,366 --> 00:19:27,933  
is the 50 years that  
a lot of the challenges

424

00:19:27,933 --> 00:19:29,866  
that we're facing  
on this planet

425

00:19:29,866 --> 00:19:31,933  
at the level of Earth

have happened.

426

00:19:31,933 --> 00:19:33,766

And so the optimism in the room

427

00:19:33,766 --> 00:19:35,333

is that we have

such great young people,

428

00:19:35,333 --> 00:19:38,800

great universities, and that we

have to come up with solutions

429

00:19:38,800 --> 00:19:42,466

that are based

in new technologies.

430

00:19:42,466 --> 00:19:44,533

Let me just give you

one last glimpse of this.

431

00:19:44,533 --> 00:19:49,066

This is the Atlantic Ocean,

number of hooks.

432

00:19:49,066 --> 00:19:50,633

This is when I was born.

433

00:19:50,633 --> 00:19:52,966

This is Japan and other nations

exploring

434

00:19:52,966 --> 00:19:55,733

what it would be like

to set hooks in log scale.

435

00:19:55,733 --> 00:19:58,233

Hot color would be

lots of hooks.

436

00:19:58,233 --> 00:20:00,866

This is when I went to--

437

00:20:00,866 --> 00:20:03,800

I guess I must have graduated  
from high school.

438

00:20:03,800 --> 00:20:06,833

This is graduating  
from college,

439

00:20:06,833 --> 00:20:08,833

red areas being very hot.

440

00:20:08,833 --> 00:20:11,766

And then this is when  
I came to Stanford.

441

00:20:11,766 --> 00:20:15,100

And now, after being  
a professor.

442

00:20:15,100 --> 00:20:18,333

So when we see these pictures,

443

00:20:18,333 --> 00:20:20,933

what they represent are  
hundreds of thousands of hooks

444

00:20:20,933 --> 00:20:24,666

in five-by-five blocks being  
set across the planet.

445

00:20:24,666 --> 00:20:27,733

And because it's out of sight  
and out of mind,

446

00:20:27,733 --> 00:20:29,566

maybe a tuna might sell for

a million dollars

447

00:20:29,566 --> 00:20:31,433

and you'll hear about it.

448

00:20:31,433 --> 00:20:33,600

That's not what  
most tunas sell for.

449

00:20:33,600 --> 00:20:36,266

But it really is amazing

450

00:20:36,266 --> 00:20:40,966

how much of the planetary  
organismal fish

451

00:20:40,966 --> 00:20:42,800

and sharks get removed  
and nobody really

452

00:20:42,800 --> 00:20:43,833

pays attention to it.

453

00:20:43,833 --> 00:20:45,500

All right?

454

00:20:45,500 --> 00:20:47,100

So we don't want our kids  
to grow up in an ocean,

455

00:20:47,100 --> 00:20:50,033

as Daniel Pauly says,  
in which we're fishing down

456

00:20:50,033 --> 00:20:51,533

the marine food chain

457

00:20:51,533 --> 00:20:53,800

and that jellyfish

will be the future.

458

00:20:53,800 --> 00:20:56,000

We want an ocean with  
healthy ecosystems.

459

00:20:56,000 --> 00:20:58,666

So to have an ocean  
with healthy ecosystems

460

00:20:58,666 --> 00:21:01,400

means we have to build  
the technologies of today

461

00:21:01,400 --> 00:21:03,866

that will take us  
into our oceans

462

00:21:03,866 --> 00:21:06,500

and allow us to see  
what's happening,

463

00:21:06,500 --> 00:21:08,833

a reef that's changing  
its acidity,

464

00:21:08,833 --> 00:21:11,966

a shark population  
that's being overfished.

465

00:21:13,466 --> 00:21:16,633

We have to use the new tools  
that we have around us

466

00:21:16,633 --> 00:21:21,333

in ways that are, really,  
ways they haven't been used.

467

00:21:21,333 --> 00:21:23,300

And so my community

of scientists

468

00:21:23,300 --> 00:21:25,100  
have responded  
to this challenge,

469

00:21:25,100 --> 00:21:27,233  
first, for the interest  
in physiology,

470

00:21:27,233 --> 00:21:30,366  
but then, because of  
the conservation need.

471

00:21:30,366 --> 00:21:32,433  
So we call the area  
of biologging,

472

00:21:32,433 --> 00:21:36,366  
the area of being able to take  
data and telemetry it back,

473

00:21:36,366 --> 00:21:39,933  
an area that, certainly,  
NASA created without question.

474

00:21:39,933 --> 00:21:42,933  
I can still remember  
being in my car

475

00:21:42,933 --> 00:21:44,633  
and hearing about an astronaut

476

00:21:44,633 --> 00:21:47,033  
who was having its body  
temperature monitored

477

00:21:47,033 --> 00:21:48,400  
and telemetered home,

478

00:21:48,400 --> 00:21:49,700

and I remember  
thinking to myself,

479

00:21:49,700 --> 00:21:51,233

gee, I'd like to do that  
in a tuna fish.

480

00:21:51,233 --> 00:21:53,966

I want to measure  
when a tuna eats a meal

481

00:21:53,966 --> 00:21:56,800

and learn in the tank  
exactly when it happens.

482

00:21:56,800 --> 00:22:00,466

So we've been building tags  
with companies for a long time,

483

00:22:00,466 --> 00:22:02,233

and these tags,  
which you might think of

484

00:22:02,233 --> 00:22:06,433

are fish-and-chips  
type of activity,

485

00:22:06,433 --> 00:22:07,700

they're helping us understand

486

00:22:07,700 --> 00:22:10,366

where everything goes  
in the sea.

487

00:22:10,366 --> 00:22:12,833

And to take back our seas,

488

00:22:12,833 --> 00:22:14,800

we're even imagining a day soon

489

00:22:14,800 --> 00:22:18,500

when chips on fish will allow us  
to catch the poachers.

490

00:22:19,600 --> 00:22:21,766

The bigger challenge we face,

491

00:22:21,766 --> 00:22:23,566

and this is one of my favorite  
images of Earth--

492

00:22:23,566 --> 00:22:26,600

it's a SeaWiFS  
satellite image--

493

00:22:26,600 --> 00:22:29,133

is we don't entirely understand  
how the ecosystems

494

00:22:29,133 --> 00:22:32,500

that these animals live in  
actually operate.

495

00:22:32,500 --> 00:22:34,666

So when we look at  
a picture of Earth--

496

00:22:34,666 --> 00:22:37,666

let's see if I can get  
the laser pointer working.

497

00:22:39,333 --> 00:22:41,200

We see this gorgeous picture

498

00:22:41,200 --> 00:22:44,466

in which the green is  
the pastures of our oceans,

499  
00:22:44,466 --> 00:22:46,500  
the blue is the deserts,

500  
00:22:46,500 --> 00:22:48,400  
and until I saw  
that image,

501  
00:22:48,400 --> 00:22:50,566  
I had learned everything  
in a textbook about oceans,

502  
00:22:50,566 --> 00:22:53,666  
but then I saw our planet and I  
realized how it really works.

503  
00:22:53,666 --> 00:22:55,333  
Here are the big gyres,

504  
00:22:55,333 --> 00:22:57,200  
where you might not want to go  
if you're feeding,

505  
00:22:57,200 --> 00:22:58,866  
and you begin to understand  
why fisheries

506  
00:22:58,866 --> 00:23:01,933  
happen along  
our coastlines.

507  
00:23:03,533 --> 00:23:05,133  
We have  
the satellite imagery

508  
00:23:05,133 --> 00:23:07,533  
but why is it we don't know  
where carnivores go

509  
00:23:07,533 --> 00:23:09,166

in the ocean?

510

00:23:09,166 --> 00:23:11,100

Why is it that all of you can  
close your eyes

511

00:23:11,100 --> 00:23:13,500

and really imagine what it's  
like when a white shark--

512

00:23:13,500 --> 00:23:16,833

excuse me, when a lion  
takes down its prey,

513

00:23:16,833 --> 00:23:18,400

but it's a little harder  
for a tuna,

514

00:23:18,400 --> 00:23:19,833

a little easier for  
a white shark

515

00:23:19,833 --> 00:23:22,433

because of Shark Week.

516

00:23:22,433 --> 00:23:24,666

We don't know the basics,  
though.

517

00:23:24,666 --> 00:23:26,000

We know how many lions  
there are,

518

00:23:26,000 --> 00:23:27,266

how many giraffes there are.

519

00:23:27,266 --> 00:23:29,466

We know we're losing elephants  
and rhinos.

520

00:23:29,466 --> 00:23:32,033

And we know the disastrous  
situation for many animals

521

00:23:32,033 --> 00:23:36,100

in the African plains  
and the Serengeti,

522

00:23:36,100 --> 00:23:38,100

but we don't really understand  
the answers

523

00:23:38,100 --> 00:23:41,366

to those questions  
for tunas and sharks.

524

00:23:41,366 --> 00:23:43,933

We barely understand  
what's going on in Monterey

525

00:23:43,933 --> 00:23:45,866

on a summer afternoon.

526

00:23:45,866 --> 00:23:47,833

Cloudy as could be  
all summer there.

527

00:23:47,833 --> 00:23:50,433

We, as oceanographers,  
have begun to figure it out.

528

00:23:50,433 --> 00:23:52,966

We know that  
the winds of spring,

529

00:23:52,966 --> 00:23:56,500

the northwest winds that  
are so strong in spring,

530

00:23:56,500 --> 00:23:59,833  
are creating upwelling, bringing  
up the nutrient-rich water

531  
00:23:59,833 --> 00:24:02,733  
that then seeds the pastures  
of summer.

532  
00:24:02,733 --> 00:24:05,233  
And that would be  
the phytoplankton

533  
00:24:05,233 --> 00:24:07,033  
that then draws in the krill

534  
00:24:07,033 --> 00:24:09,166  
that then brings the anchovy

535  
00:24:09,166 --> 00:24:11,466  
or the sardine

536  
00:24:11,466 --> 00:24:13,666  
and then brings in  
the blue whale, the humpback,

537  
00:24:13,666 --> 00:24:16,200  
and the bluefin tuna.

538  
00:24:16,200 --> 00:24:19,200  
We barely understand,  
until our tagging program,

539  
00:24:19,200 --> 00:24:21,700  
where the places,  
like for wildebeest are,

540  
00:24:21,700 --> 00:24:24,000  
in which there might be  
a long migration

541  
00:24:24,000 --> 00:24:26,400  
or how the seasonal migrations  
of the Serengeti

542  
00:24:26,400 --> 00:24:28,866  
might work at an ocean scale

543  
00:24:28,866 --> 00:24:30,700  
and who'd be at  
the watering hole.

544  
00:24:30,700 --> 00:24:33,033  
And it wasn't until 2002  
that we began

545  
00:24:33,033 --> 00:24:36,900  
actually putting the first  
electronics on a bluefin tuna

546  
00:24:36,900 --> 00:24:39,733  
who might swim from our side  
back to Japan

547  
00:24:39,733 --> 00:24:41,633  
and down to New Zealand and back

548  
00:24:41,633 --> 00:24:45,166  
and hope that we might see  
that tag again.

549  
00:24:45,166 --> 00:24:48,133  
All right, so the challenge is  
not only in the electronics

550  
00:24:48,133 --> 00:24:50,666  
but it's also  
in the challenge of

551  
00:24:50,666 --> 00:24:53,533

how do you put things  
on large objects

552

00:24:53,533 --> 00:24:56,166  
that move through a fluid medium  
that has a lot of salt?

553

00:24:56,166 --> 00:24:57,800  
And how do you keep  
the engineering going?

554

00:24:57,800 --> 00:25:00,600  
Or how, like my colleagues  
in TOPP,

555

00:25:00,600 --> 00:25:03,533  
Dr. Bruce Mate from  
Oregon State University,

556

00:25:03,533 --> 00:25:06,166  
how do you go up  
to a blue whale

557

00:25:06,166 --> 00:25:08,500  
and put an electronic tag  
on a blue whale?

558

00:25:08,500 --> 00:25:10,800  
And then how do you take  
all of this

559

00:25:10,800 --> 00:25:13,933  
and put it in a context  
of a moving fluid

560

00:25:13,933 --> 00:25:17,833  
that changes at both seasonal  
and decadal scales

561

00:25:17,833 --> 00:25:21,566

and tell a story about  
how our planet Earth functions?

562

00:25:23,333 --> 00:25:26,133

So you begin by building  
a tuna center,

563

00:25:26,133 --> 00:25:27,766

which we did in 1994,

564

00:25:27,766 --> 00:25:29,933

with the Monterey Bay Aquarium  
in Stanford,

565

00:25:29,933 --> 00:25:32,366

and then you have to convince  
your colleagues,

566

00:25:32,366 --> 00:25:34,933

your engineers,  
that this is an exciting area.

567

00:25:34,933 --> 00:25:38,566

It's not the most well-funded  
part of our science stream,

568

00:25:38,566 --> 00:25:41,033

but what we began doing,

569

00:25:41,033 --> 00:25:43,333

partnering with the Navy

570

00:25:43,333 --> 00:25:44,900

and NOAA

571

00:25:44,900 --> 00:25:47,733

and many different funding  
streams under NOPP,

572

00:25:47,733 --> 00:25:49,866  
is we began building  
the instruments we needed

573  
00:25:49,866 --> 00:25:51,566  
to put on the animals

574  
00:25:51,566 --> 00:25:53,700  
that we could measure  
what's happening in the ocean.

575  
00:25:55,266 --> 00:25:58,833  
My favorite instrument that we  
spent a lot of time building

576  
00:25:58,833 --> 00:26:00,600  
is called an archival tag.

577  
00:26:00,600 --> 00:26:02,300  
It's simply a computer.

578  
00:26:02,300 --> 00:26:05,366  
I'd say it has the most  
sensitive light sensor

579  
00:26:05,366 --> 00:26:06,966  
on the planet.

580  
00:26:06,966 --> 00:26:10,066  
It's arguable, but it's  
a nine-decade light sensor,

581  
00:26:10,066 --> 00:26:13,066  
has oceanographic quality  
temperature and pressure.

582  
00:26:13,066 --> 00:26:15,900  
It goes into a fish surgically.

583

00:26:15,900 --> 00:26:17,200

The fish carries it  
in the ocean,

584

00:26:17,200 --> 00:26:20,233

and we want to get it back  
up to six years later,

585

00:26:20,233 --> 00:26:21,800

that's what we're doing  
right now,

586

00:26:21,800 --> 00:26:24,100

and tell the journey  
that fish took.

587

00:26:24,100 --> 00:26:25,466

How do we do that?

588

00:26:25,466 --> 00:26:28,000

Well, we have to depend upon  
humans to get it back.

589

00:26:28,000 --> 00:26:29,666

That's not always a good thing  
to depend upon.

590

00:26:29,666 --> 00:26:31,933

So there's a fishery,  
targeted fishery,

591

00:26:31,933 --> 00:26:34,066

in which there's about three  
or four languages on the tag.

592

00:26:34,066 --> 00:26:36,900

It says return the tag,  
return the computer,

593

00:26:36,900 --> 00:26:38,400

and if you get it back,

594

00:26:38,400 --> 00:26:40,266

we're able, underneath the sea,

595

00:26:40,266 --> 00:26:42,133

to draw a map of a fish

that was tagged here

596

00:26:42,133 --> 00:26:45,233

went up the coast,

moved offshore once,

597

00:26:45,233 --> 00:26:46,900

all the way back again,

598

00:26:46,900 --> 00:26:48,733

and then went back to Japan

and got caught.

599

00:26:48,733 --> 00:26:50,866

So how did we do that?

600

00:26:50,866 --> 00:26:53,166

We did it using

the mathematics

601

00:26:53,166 --> 00:26:56,000

that was invested

in astronomy

602

00:26:56,000 --> 00:26:58,066

and sailing

from a long time ago,

603

00:26:58,066 --> 00:27:00,266

and that is if I have

an accurate clock,

604

00:27:00,266 --> 00:27:02,133  
not an easy thing to build  
and keep in a tuna,

605  
00:27:02,133 --> 00:27:04,466  
and I have photons,

606  
00:27:04,466 --> 00:27:06,866  
I can measure  
sunrise and sunset,

607  
00:27:06,866 --> 00:27:09,766  
and I can actually do  
mathematical algorithms

608  
00:27:09,766 --> 00:27:12,066  
that tell me where I am  
on the planet

609  
00:27:12,066 --> 00:27:15,066  
and correct  
for the diving fish.

610  
00:27:15,066 --> 00:27:16,466  
All right, so that's  
what we're doing.

611  
00:27:16,466 --> 00:27:18,733  
And that geo-location

612  
00:27:18,733 --> 00:27:22,000  
has now been put into  
a variety of tag types

613  
00:27:22,000 --> 00:27:24,300  
that sometimes  
you have to get back

614  
00:27:24,300 --> 00:27:27,333  
and at other times you can

actually pop it off the animal

615

00:27:27,333 --> 00:27:29,533

and get it back through  
satellite uplink.

616

00:27:29,533 --> 00:27:31,900

And I'm gonna tell you about  
a whole family of tags

617

00:27:31,900 --> 00:27:34,733

that engineers have built  
around the biologging community

618

00:27:34,733 --> 00:27:37,666

that have really led  
to a breakthrough

619

00:27:37,666 --> 00:27:39,700

in understanding  
where animals go.

620

00:27:39,700 --> 00:27:43,133

A second type of tag that  
happens in animal tagging

621

00:27:43,133 --> 00:27:44,500

is obvious to most people.

622

00:27:44,500 --> 00:27:46,700

You put a radio tag  
on the back of an animal.

623

00:27:46,700 --> 00:27:49,266

When it comes to the surface,  
it sends up its signal.

624

00:27:49,266 --> 00:27:51,800

But it's harder to put that  
on a fish

625

00:27:51,800 --> 00:27:53,400

'cause fish don't come  
to the surface.

626

00:27:53,400 --> 00:27:56,766

So we use pop-up satellite  
archival tags at the top.

627

00:27:56,766 --> 00:28:00,866

Sometimes we can take  
a dorsal fin of a shark

628

00:28:00,866 --> 00:28:03,300

and we can put a tag  
at the tip.

629

00:28:03,300 --> 00:28:05,233

We're only learning every day  
more and more

630

00:28:05,233 --> 00:28:06,600

about how to do this.

631

00:28:06,600 --> 00:28:09,000

We can send  
Argos satellite signals.

632

00:28:09,000 --> 00:28:11,000

We can now send GPS signals.

633

00:28:11,000 --> 00:28:13,233

We're only just, as a community,

634

00:28:13,233 --> 00:28:14,933

learning how to do that well.

635

00:28:14,933 --> 00:28:17,533

We helped to bring

Fastloc technology

636

00:28:17,533 --> 00:28:21,666  
from military applications  
into the marine realm

637

00:28:21,666 --> 00:28:23,666  
because when an animal comes to  
the surface,

638

00:28:23,666 --> 00:28:25,066  
like a whale, and goes...

639

00:28:25,066 --> 00:28:26,166  
[breathes in and out]

640

00:28:26,166 --> 00:28:28,666  
And gets a breath,  
or a pinniped,

641

00:28:28,666 --> 00:28:30,300  
it's not there for very long.

642

00:28:30,300 --> 00:28:31,933  
And so how long does it take

643

00:28:31,933 --> 00:28:34,966  
to get a global satellite  
signal?

644

00:28:34,966 --> 00:28:37,600  
A lot longer than a breathing  
whale at the surface

645

00:28:37,600 --> 00:28:40,033  
or a shark who's finning.

646

00:28:40,033 --> 00:28:41,866  
This is the first shark

over the past year

647

00:28:41,866 --> 00:28:44,833

that we've put GPS at the tip  
of its dorsal fin,

648

00:28:44,833 --> 00:28:50,000

and what we're able to do is--  
in tan is our Argos signal,

649

00:28:50,000 --> 00:28:51,433

and yellow is our GPS signal.

650

00:28:51,433 --> 00:28:53,233

I didn't put  
the geo-location signal,

651

00:28:53,233 --> 00:28:55,500

but we learned that, you know,  
we're doing pretty well

652

00:28:55,500 --> 00:28:57,866

with the methodologies  
we have

653

00:28:57,866 --> 00:29:00,300

and GPS is getting us  
somewhere there,

654

00:29:00,300 --> 00:29:02,400

but it's hard to get the signal  
off the animal.

655

00:29:02,400 --> 00:29:04,300

So these are the types of tags.

656

00:29:04,300 --> 00:29:06,200

The most complex tags  
we're doing right now

657  
00:29:06,200 --> 00:29:08,500  
are camera tags  
with magnetometers

658  
00:29:08,500 --> 00:29:12,100  
and accelerometers that tell us  
everything about pitch

659  
00:29:12,100 --> 00:29:14,466  
and speed underneath the sea.

660  
00:29:14,466 --> 00:29:16,433  
And we're trying to put these  
on tunas and sharks

661  
00:29:16,433 --> 00:29:18,433  
and find out how they work.

662  
00:29:18,433 --> 00:29:20,266  
But the most important thing  
we do

663  
00:29:20,266 --> 00:29:22,433  
is we get a lot of points  
about animals

664  
00:29:22,433 --> 00:29:24,600  
who are the most targeted  
animals on the planet,

665  
00:29:24,600 --> 00:29:27,433  
about 100,000 points  
from 2,000 days of tagging,

666  
00:29:27,433 --> 00:29:30,866  
huge amounts of effort catching  
each fish individually.

667  
00:29:30,866 --> 00:29:33,966

And in the Pacific--I took this  
off the web this morning.

668

00:29:33,966 --> 00:29:36,900

There's--  
this is from ten hours ago,

669

00:29:36,900 --> 00:29:38,933

it says, "Pacific bluefin tuna  
could become extinct

670

00:29:38,933 --> 00:29:40,333

without a fishing ban."

671

00:29:40,333 --> 00:29:42,633

All right, so the importance  
of this type of work

672

00:29:42,633 --> 00:29:45,666

is that without finding out  
what they do,

673

00:29:45,666 --> 00:29:47,566

we can't manage these animals.

674

00:29:47,566 --> 00:29:49,100

So I'm gonna give you  
a couple of examples.

675

00:29:49,100 --> 00:29:50,933

This is the Atlantic Ocean.

676

00:29:50,933 --> 00:29:55,400

60 nations are meeting next  
week in Europe, in Spain,

677

00:29:55,400 --> 00:29:57,733

to decide, how does  
the science support

678  
00:29:57,733 --> 00:30:01,466  
best splitting up  
the last tuna

679  
00:30:01,466 --> 00:30:02,933  
for the two different sides  
of the ocean,

680  
00:30:02,933 --> 00:30:06,300  
and how can we best manage  
what we hope is a recovery?

681  
00:30:06,300 --> 00:30:07,900  
So we have two populations

682  
00:30:07,900 --> 00:30:10,666  
that are thought to not cross  
the ocean originally,

683  
00:30:10,666 --> 00:30:12,600  
but now we've learned  
from tagging, they do.

684  
00:30:12,600 --> 00:30:15,433  
We manage the western side of  
the basin differently

685  
00:30:15,433 --> 00:30:16,800  
than the eastern side.

686  
00:30:16,800 --> 00:30:19,300  
We have a smaller stock  
in the west off North America,

687  
00:30:19,300 --> 00:30:21,200  
a larger stock in the Med.

688  
00:30:21,200 --> 00:30:22,966  
This is the American stock,

689

00:30:22,966 --> 00:30:24,700

so this is lots of  
breeding tunas.

690

00:30:24,700 --> 00:30:27,466

It declined long ago,

691

00:30:27,466 --> 00:30:29,866

hovering near its minimum  
down here.

692

00:30:29,866 --> 00:30:32,600

Maybe there's an uptick, but  
then we had a Gulf oil spill,

693

00:30:32,600 --> 00:30:35,333

and it's not really clear  
what's going on.

694

00:30:35,333 --> 00:30:36,933

So as I mentioned,

695

00:30:36,933 --> 00:30:39,900

we surgically put these tags  
into the tuna,

696

00:30:39,900 --> 00:30:41,366

we let them go,

697

00:30:41,366 --> 00:30:46,100

we mark the tuna with  
a small mark that's green

698

00:30:46,100 --> 00:30:49,333

that says if you return me,  
you'll get \$1,000.

699

00:30:49,333 --> 00:30:51,866

And we get fishermen  
returning the tags,

700  
00:30:51,866 --> 00:30:54,066  
and when they return  
the big tunas,

701  
00:30:54,066 --> 00:30:57,000  
it's about 22% of  
our instruments come back,

702  
00:30:57,000 --> 00:30:58,600  
and the small tunas,

703  
00:30:58,600 --> 00:31:00,733  
where there's a higher  
mortality rate in the Pacific,

704  
00:31:00,733 --> 00:31:02,200  
we get about half of them back,

705  
00:31:02,200 --> 00:31:05,266  
and that's a lot to get back  
from a wild ocean.

706  
00:31:05,266 --> 00:31:08,600  
So then what we do is we  
compute where the fish went.

707  
00:31:08,600 --> 00:31:12,600  
So in the color is a track  
of a fish beneath the sea.

708  
00:31:12,600 --> 00:31:14,066  
It's never sent us  
a radio signal.

709  
00:31:14,066 --> 00:31:15,900  
This is all  
beneath the sea,

710

00:31:15,900 --> 00:31:17,666

all done with  
a geo-location algorithm.

711

00:31:17,666 --> 00:31:20,566

It's a probability function of  
where is the animal?

712

00:31:20,566 --> 00:31:23,133

We hook those probabilities  
together with an error,

713

00:31:23,133 --> 00:31:25,600

and then what  
we're able to do

714

00:31:25,600 --> 00:31:27,233

is run a states-based model  
that,

715

00:31:27,233 --> 00:31:30,733

over time, has improved  
telling us where an animal

716

00:31:30,733 --> 00:31:33,200

that's completely  
beneath the sea is going.

717

00:31:33,200 --> 00:31:36,533

And what is the reward for  
your hard work over 20 years

718

00:31:36,533 --> 00:31:38,233

is to get tracks like this.

719

00:31:38,233 --> 00:31:39,766

The colors are day--or months

720

00:31:39,766 --> 00:31:41,300  
in which the first year  
the animal,

721  
00:31:41,300 --> 00:31:44,500  
he was over in America, then  
the animal went to Ireland,

722  
00:31:44,500 --> 00:31:47,166  
and then Ireland to Spain

723  
00:31:47,166 --> 00:31:48,566  
and back and forth again.

724  
00:31:48,566 --> 00:31:49,933  
They breed  
in the Mediterranean,

725  
00:31:49,933 --> 00:31:51,600  
so you start over here  
and realize

726  
00:31:51,600 --> 00:31:54,133  
that a fish that you met  
off the coast of North Carolina

727  
00:31:54,133 --> 00:31:56,100  
is really  
a Mediterranean breeder.

728  
00:31:56,100 --> 00:31:58,733  
So we begin to separate  
who's who in the ocean.

729  
00:31:58,733 --> 00:32:01,633  
Another example,  
a fish in the first year

730  
00:32:01,633 --> 00:32:04,000  
swimming right across to Spain

731

00:32:04,000 --> 00:32:06,933  
and then the same thing, going  
in the Balearics to breed

732

00:32:06,933 --> 00:32:08,300  
for three years in a row.

733

00:32:08,300 --> 00:32:10,133  
And so it's through  
this type of activity

734

00:32:10,133 --> 00:32:12,733  
that we can begin to separate  
populations.

735

00:32:12,733 --> 00:32:14,833  
This is a population--  
this is one fish

736

00:32:14,833 --> 00:32:17,433  
who's gone into the Gulf twice  
to breed.

737

00:32:17,433 --> 00:32:21,000  
And we begin to see that there  
is a very, very small

738

00:32:21,000 --> 00:32:23,400  
North American  
giant bluefin tuna

739

00:32:23,400 --> 00:32:25,400  
that's separate from  
the European bluefin tuna,

740

00:32:25,400 --> 00:32:27,900  
but they mix  
on their foraging grounds.

741

00:32:27,900 --> 00:32:31,733

We can also see into the ocean  
with the animal as it dives.

742

00:32:31,733 --> 00:32:34,566

It's become a sensor.

743

00:32:34,566 --> 00:32:36,466

There's the day in the life  
of a tuna down here

744

00:32:36,466 --> 00:32:38,800

in which the animal's diving

745

00:32:38,800 --> 00:32:40,566

maybe to get a cod  
or something like that.

746

00:32:40,566 --> 00:32:41,833

This is  
the ambient temperature.

747

00:32:41,833 --> 00:32:43,800

There's the warm-body  
temperature.

748

00:32:43,800 --> 00:32:46,633

The animal is moving along  
this trajectory,

749

00:32:46,633 --> 00:32:49,166

and over the life  
of this tag,

750

00:32:49,166 --> 00:32:52,233

a year and a half of data,  
you get this gorgeous data

751

00:32:52,233 --> 00:32:55,700

at the level of  
oceanographic equipment.

752

00:32:55,700 --> 00:32:59,800

To get the pop-up tag to work  
took a lot of effort

753

00:32:59,800 --> 00:33:01,266

by many people,

754

00:33:01,266 --> 00:33:04,566

and so this is pop-up tagging  
here at Monterey.

755

00:33:04,566 --> 00:33:07,933

Learning how to pop the tags  
off first in pens

756

00:33:07,933 --> 00:33:09,233

and then building an instrument

757

00:33:09,233 --> 00:33:11,266

that was robust enough to work  
in the wild.

758

00:33:11,266 --> 00:33:12,933

Now, what we do routinely

759

00:33:12,933 --> 00:33:16,600

is put the external tag  
on the outside of a fish.

760

00:33:16,600 --> 00:33:18,300

It's pretty hard to keep it on.

761

00:33:18,300 --> 00:33:21,000

It's 30 grams,  
hard to get it smaller

762

00:33:21,000 --> 00:33:23,366  
with its radio transmitters.

763

00:33:23,366 --> 00:33:26,266  
It then does all  
the computational math

764

00:33:26,266 --> 00:33:28,666  
of the modeling  
of sunrise and sunset

765

00:33:28,666 --> 00:33:30,666  
on the tag.

766

00:33:30,666 --> 00:33:32,866  
We correct the latitude

767

00:33:32,866 --> 00:33:35,633  
by taking the zero pressure  
in blue

768

00:33:35,633 --> 00:33:38,166  
and temperature  
and fitting that with

769

00:33:38,166 --> 00:33:39,400  
sea surface temperature

770

00:33:39,400 --> 00:33:41,800  
we get from satellites  
from NASA and NOAA.

771

00:33:41,800 --> 00:33:44,666  
We then can bring these two  
models of where the fish is

772

00:33:44,666 --> 00:33:46,733  
along a known light longitude  
together

773

00:33:46,733 --> 00:33:48,500

and then get that probability.

774

00:33:48,500 --> 00:33:50,733

And the hard part about  
pop-up tags

775

00:33:50,733 --> 00:33:52,633

is you have to send  
that data back.

776

00:33:52,633 --> 00:33:56,000

So the tag is small, it rides,  
records all this data.

777

00:33:56,000 --> 00:33:58,733

It does some smart  
computational functions,

778

00:33:58,733 --> 00:34:00,600

comes to the surface  
on a release

779

00:34:00,600 --> 00:34:02,200

that you program in,

780

00:34:02,200 --> 00:34:06,033

and then sends the data  
back to Argos system.

781

00:34:06,033 --> 00:34:09,700

So then we're able to take  
imagery from NASA and NOAA,

782

00:34:09,700 --> 00:34:11,066

bring it together  
with the track,

783

00:34:11,066 --> 00:34:12,600

and for the first time  
in our lives,

784  
00:34:12,600 --> 00:34:15,766  
really see how it is that  
the Gulf Stream becomes,

785  
00:34:15,766 --> 00:34:19,600  
for example,  
the transporter of the tuna

786  
00:34:19,600 --> 00:34:22,066  
and how rings off  
the Gulf Stream are places

787  
00:34:22,066 --> 00:34:24,233  
that they really love to go,

788  
00:34:24,233 --> 00:34:28,666  
and then how an animal might  
probe the Gulf of Maine,

789  
00:34:28,666 --> 00:34:30,566  
look for something in there,  
find it's too cold,

790  
00:34:30,566 --> 00:34:33,866  
and then go back before heading  
back down to North Carolina.

791  
00:34:33,866 --> 00:34:36,866  
And so this type of work  
is challenging to do.

792  
00:34:38,633 --> 00:34:41,000  
So we are also able to,  
as I said,

793  
00:34:41,000 --> 00:34:43,533  
send back these

oceanographic signals,

794

00:34:43,533 --> 00:34:47,333

find out how a fish  
in a population

795

00:34:47,333 --> 00:34:49,066

are using the Gulf of Mexico.

796

00:34:49,066 --> 00:34:51,833

We're able to see that  
some of these fish

797

00:34:51,833 --> 00:34:54,600

move across to  
the Mediterranean,

798

00:34:54,600 --> 00:34:57,366

as I told you,  
combine it with genetics,

799

00:34:57,366 --> 00:35:01,033

such that we can see Gulf fish,  
Mediterranean fish,

800

00:35:01,033 --> 00:35:03,666

and fish that are sort of  
in the North Atlantic.

801

00:35:03,666 --> 00:35:06,300

We can use ear bones  
with elements

802

00:35:06,300 --> 00:35:08,466

to tell us  
from which population,

803

00:35:08,466 --> 00:35:10,600

red from the Gulf  
and blue from the Med,

804

00:35:10,600 --> 00:35:13,033

saltier sea

the animals come from

805

00:35:13,033 --> 00:35:14,733

and we take all this

information

806

00:35:14,733 --> 00:35:17,133

and, for the first time,

we're able to say to the world

807

00:35:17,133 --> 00:35:18,500

there's two populations,

808

00:35:18,500 --> 00:35:20,600

maybe a third that's

residential in the Med,

809

00:35:20,600 --> 00:35:22,466

and we need to manage

the mathematics

810

00:35:22,466 --> 00:35:24,800

of how many tunas there are

with this understanding

811

00:35:24,800 --> 00:35:27,333

and tell the bodies

that manage the tuna

812

00:35:27,333 --> 00:35:30,400

that your models need to have

an overlap mathematics

813

00:35:30,400 --> 00:35:32,600

and not this separation.

814

00:35:32,600 --> 00:35:35,800

Tunas also came into  
the Gulf of Mexico to breed.

815

00:35:35,800 --> 00:35:38,900

And this is where we had  
the world's largest oil spill

816

00:35:38,900 --> 00:35:40,366

not too long ago,

817

00:35:40,366 --> 00:35:42,233

and we're just publishing  
some papers now

818

00:35:42,233 --> 00:35:45,366

in which we look at  
what happened after spawning,

819

00:35:45,366 --> 00:35:48,300

what did the Gulf oil do  
to the animals,

820

00:35:48,300 --> 00:35:49,566

and what did it do to their  
spawn

821

00:35:49,566 --> 00:35:52,000

that's going to impact  
the population?

822

00:35:52,000 --> 00:35:55,066

And we do that with satellite  
oceanography again

823

00:35:55,066 --> 00:35:57,333

coming from both NOAA and NASA  
in which

824

00:35:57,333 --> 00:35:59,433

along a trajectory  
of where a tuna is,

825

00:35:59,433 --> 00:36:01,600

we can tell a behavior  
of spawning.

826

00:36:01,600 --> 00:36:04,933

That is, we can tell when the  
tunas, if you will, have sex.

827

00:36:04,933 --> 00:36:07,266

And they do, like us,  
some unusual things.

828

00:36:07,266 --> 00:36:08,633

I'm not gonna go into  
the detail.

829

00:36:08,633 --> 00:36:10,500

They have a pattern up here  
of behavior,

830

00:36:10,500 --> 00:36:11,633

of temperature and pressure

831

00:36:11,633 --> 00:36:12,966

that you could almost  
with your eyes

832

00:36:12,966 --> 00:36:15,366

see on a dial base,  
is different

833

00:36:15,366 --> 00:36:17,233

than the pattern below.

834

00:36:17,233 --> 00:36:20,400

And we know from our own work  
physiologically

835

00:36:20,400 --> 00:36:24,166  
that petroleum is  
a cardiac arrhythmic agent.

836

00:36:24,166 --> 00:36:25,900  
We actually--I showed that.

837

00:36:25,900 --> 00:36:27,966  
And so we can actually then  
make some population estimates

838

00:36:27,966 --> 00:36:32,166  
of what happened when tunas  
spawn in oceanographic places

839

00:36:32,166 --> 00:36:33,633  
that are oiled.

840

00:36:33,633 --> 00:36:35,066  
So we can bring the layers  
together

841

00:36:35,066 --> 00:36:38,100  
and then ask the question,  
what was the probability

842

00:36:38,100 --> 00:36:41,300  
in the oil spill  
of a tuna habitat

843

00:36:41,300 --> 00:36:43,400  
in high probability green

844

00:36:43,400 --> 00:36:44,666  
being covered with oil,

845

00:36:44,666 --> 00:36:47,066  
and then also having

a spawning event occur?

846

00:36:47,066 --> 00:36:49,400

And that's how we bring  
together these disparate fields

847

00:36:49,400 --> 00:36:52,000

of satellite oceanography  
and behavior.

848

00:36:52,000 --> 00:36:54,166

I'm gonna skip past this  
because of time

849

00:36:54,166 --> 00:36:56,866

and tell you slightly about  
our other project.

850

00:36:56,866 --> 00:36:58,166

So out here in the Pacific,

851

00:36:58,166 --> 00:36:59,633

which is a bit more  
of the unknown,

852

00:36:59,633 --> 00:37:02,366

we have big sanctuaries  
and we're trying to understand,

853

00:37:02,366 --> 00:37:04,766

as I mentioned, we've been  
talking about the tunas,

854

00:37:04,766 --> 00:37:07,800

how does an ocean  
as big as the Pacific operate?

855

00:37:07,800 --> 00:37:11,100

To do that, we took  
all of our equipment,

856

00:37:11,100 --> 00:37:13,333

our satellite tags  
on the heads of seals,

857

00:37:13,333 --> 00:37:16,300

our pop-up tags,  
our tuna archival tags,

858

00:37:16,300 --> 00:37:18,600

and the simple questions  
that we're asking are,

859

00:37:18,600 --> 00:37:21,000

if we understand that  
there's a relationship

860

00:37:21,000 --> 00:37:22,700

between upwelling  
and productivity,

861

00:37:22,700 --> 00:37:25,700

how do you get optimum habitat  
off California,

862

00:37:25,700 --> 00:37:27,633

and why does it occur only

863

00:37:27,633 --> 00:37:29,466

for about four to five months  
of the year?

864

00:37:29,466 --> 00:37:31,066

Why is the hot spot,  
if you will,

865

00:37:31,066 --> 00:37:33,866

July to November?

866

00:37:33,866 --> 00:37:37,166

So we satellite  
oceanographically tagged

867

00:37:37,166 --> 00:37:41,300

from UCSC and Daniel Costa's  
lab in TOPP

868

00:37:41,300 --> 00:37:44,200

the e-seals off of--

869

00:37:44,200 --> 00:37:46,633

off of Año Nuevo.

870

00:37:46,633 --> 00:37:49,200

We built special tags with  
our British colleagues

871

00:37:49,200 --> 00:37:52,466

that carried CTDs on the top  
there.

872

00:37:52,466 --> 00:37:54,200

So these are true CTDs  
like you'd see

873

00:37:54,200 --> 00:37:55,966

off an oceanographic ship.

874

00:37:55,966 --> 00:37:58,333

They measure salinity,  
temperature.

875

00:37:58,333 --> 00:37:59,966

They now do  
fluorescents,

876

00:37:59,966 --> 00:38:02,333

and we put this  
on animals

877

00:38:02,333 --> 00:38:04,666  
along with the Fastloc GPS,

878

00:38:04,666 --> 00:38:06,800  
and we began to get, you know,  
precision oceanography

879

00:38:06,800 --> 00:38:08,400  
about what they're doing.

880

00:38:08,400 --> 00:38:10,466  
And what we learned from  
this type of activity

881

00:38:10,466 --> 00:38:14,066  
the elephant seal goes 1/3 to  
halfway across the Pacific

882

00:38:14,066 --> 00:38:15,300  
and comes back to the beach

883

00:38:15,300 --> 00:38:16,633  
where you can get  
the data back.

884

00:38:16,633 --> 00:38:18,866  
We've got the sharks  
I told you about.

885

00:38:18,866 --> 00:38:21,400  
Here's some salmon sharks here,  
some tuna here.

886

00:38:21,400 --> 00:38:23,933  
We found that we had a  
neighborhood in our backyard,

887

00:38:23,933 --> 00:38:25,933

that we have this ocean called  
the Pacific.

888

00:38:25,933 --> 00:38:27,633

But once we put tags on,

889

00:38:27,633 --> 00:38:29,500

we found that from Hawaii

to here is sort of

890

00:38:29,500 --> 00:38:30,633

an ocean neighborhood,

891

00:38:30,633 --> 00:38:33,133

and then in the summer months

892

00:38:33,133 --> 00:38:36,666

from New Zealand, from

Indonesia, from the Bering Sea,

893

00:38:36,666 --> 00:38:39,066

animals know it's such

a great place to feed--

894

00:38:39,066 --> 00:38:41,433

it's sort of the McDonald's

of the west coast--

895

00:38:41,433 --> 00:38:44,333

that they all come up here,

unremarkable migrations,

896

00:38:44,333 --> 00:38:46,466

to feed here.

897

00:38:46,466 --> 00:38:48,800

And so what we learned by

studying many animals

898

00:38:48,800 --> 00:38:51,466  
and guilds working together  
as scientists

899  
00:38:51,466 --> 00:38:54,000  
is that the west coast  
of North America

900  
00:38:54,000 --> 00:38:57,700  
has a place that attracts  
albatross, that has tunas,

901  
00:38:57,700 --> 00:38:59,333  
that has sharks,  
and for the first time,

902  
00:38:59,333 --> 00:39:01,800  
we could separate in colors  
their different species

903  
00:39:01,800 --> 00:39:04,433  
and their habitats  
with tagging.

904  
00:39:04,433 --> 00:39:05,900  
And the main result  
of the project

905  
00:39:05,900 --> 00:39:09,433  
was to learn, in red,  
that if you tag 4,000 animals

906  
00:39:09,433 --> 00:39:11,200  
and get tens of thousands,

907  
00:39:11,200 --> 00:39:12,466  
hundreds of thousands  
of points,

908  
00:39:12,466 --> 00:39:14,766

that the hot spot,  
after you correct for

909  
00:39:14,766 --> 00:39:16,933  
having put many of the tags  
in the west coast,

910  
00:39:16,933 --> 00:39:20,033  
isn't just a diffusional place  
that they go to

911  
00:39:20,033 --> 00:39:21,233  
because you  
tagged them here.

912  
00:39:21,233 --> 00:39:22,966  
The hot spot is here  
because

913  
00:39:22,966 --> 00:39:25,233  
it's actually aggregating  
much of the wildlife

914  
00:39:25,233 --> 00:39:29,166  
of the Pacific in  
the northern Pacific Ocean.

915  
00:39:29,166 --> 00:39:31,033  
And there's three hot spots  
in particular.

916  
00:39:31,033 --> 00:39:34,100  
We found the highway, the  
North Pacific Transition Zone,

917  
00:39:34,100 --> 00:39:37,600  
the California Current,  
and the White Shark Café.

918  
00:39:37,600 --> 00:39:40,300

We also found that,  
much to our surprise,

919  
00:39:40,300 --> 00:39:41,866  
when we started,  
we didn't really know this,

920  
00:39:41,866 --> 00:39:44,600  
that if you take  
oceanographic values--

921  
00:39:44,600 --> 00:39:46,233  
this would be chlorophyll.

922  
00:39:46,233 --> 00:39:48,400  
This down here is temperature  
with red being warm colors.

923  
00:39:48,400 --> 00:39:50,966  
and you run the mean latitude  
of all these guilds

924  
00:39:50,966 --> 00:39:53,866  
through the year, that there's  
a very seasonal pattern

925  
00:39:53,866 --> 00:39:57,333  
of either going north-south  
or going inshore-offshore,

926  
00:39:57,333 --> 00:39:59,833  
that there's actually a clock  
that the animals are on.

927  
00:39:59,833 --> 00:40:01,633  
That clock is a seasonal clock

928  
00:40:01,633 --> 00:40:03,666  
in which this is the hot spot.

929

00:40:03,666 --> 00:40:05,800

All of the west coast  
of North America in blue

930

00:40:05,800 --> 00:40:07,666

are transit periods

931

00:40:07,666 --> 00:40:10,233

and yellow is  
the residency period.

932

00:40:10,233 --> 00:40:12,700

So I've told you a lot about  
Pacific bluefin tuna.

933

00:40:12,700 --> 00:40:15,400

I'm not gonna say--  
I mean, Atlantic bluefin tuna.

934

00:40:15,400 --> 00:40:18,333

On the Pacific side,  
a tuna would be tagged,

935

00:40:18,333 --> 00:40:21,033

excuse me,  
and go north and south

936

00:40:21,033 --> 00:40:22,866

for quite some time.

937

00:40:22,866 --> 00:40:26,133

And in blue is bluefin,  
in red is yellowfin,

938

00:40:26,133 --> 00:40:27,633

three different species,

939

00:40:27,633 --> 00:40:29,033

in white will be albacore tuna.

940

00:40:29,033 --> 00:40:31,333

Those are the tunas of the west coast of North America.

941

00:40:31,333 --> 00:40:34,766

This would be a NASA-generated

942

00:40:34,766 --> 00:40:38,800

surface temperature map from JPL.

943

00:40:38,800 --> 00:40:40,600

And what we'll have is then tuna showing you

944

00:40:40,600 --> 00:40:42,600

their migration highway home.

945

00:40:42,600 --> 00:40:44,633

They always go along that highway.

946

00:40:44,633 --> 00:40:46,433

And then we'll see that in red, the yellowfin tuna

947

00:40:46,433 --> 00:40:47,633

will be clinging to North America.

948

00:40:47,633 --> 00:40:48,800

They'll stay here.

949

00:40:48,800 --> 00:40:50,433

That's what makes the population.

950

00:40:50,433 --> 00:40:54,433

And then the albacore are going out towards the café.

951

00:40:54,433 --> 00:40:56,833

Perhaps the biggest migrators we learned,

952

00:40:56,833 --> 00:40:59,333

we took tuna tags and, through the work of Scott Shaffer

953

00:40:59,333 --> 00:41:01,233

at San Jose State,

954

00:41:01,233 --> 00:41:03,800

we were able to show with light-based geo-location

955

00:41:03,800 --> 00:41:05,733

that animals as small as shearwaters

956

00:41:05,733 --> 00:41:07,933

that you see here in the summer are coming up from New Zealand,

957

00:41:07,933 --> 00:41:10,133

ending up on our coast,

958

00:41:10,133 --> 00:41:12,166

maybe going over to Japan, and then coming back down

959

00:41:12,166 --> 00:41:14,533

on some of the largest migrations on the planet.

960

00:41:14,533 --> 00:41:16,966

These are with small light-based geo-location tags

961

00:41:16,966 --> 00:41:19,766

that the birds carry  
on their feet.

962

00:41:19,766 --> 00:41:21,800

And when we do all this tagging  
together,

963

00:41:21,800 --> 00:41:23,366

we begin to see that  
we understand

964

00:41:23,366 --> 00:41:25,033

that the transition zone,

965

00:41:25,033 --> 00:41:27,100

we need satellites  
to really see this,

966

00:41:27,100 --> 00:41:30,700

is between the subarctic front  
and the subtropical gyre

967

00:41:30,700 --> 00:41:32,866

that an albatross  
on a single trip

968

00:41:32,866 --> 00:41:36,266

will use that frontal zone  
with a satellite tag

969

00:41:36,266 --> 00:41:38,700

that a Pacific bluefin tuna  
will migrate

970

00:41:38,700 --> 00:41:41,500

along this frontal zone  
and so will the elephant seals

971  
00:41:41,500 --> 00:41:42,900  
'cause that's where  
the food is.

972  
00:41:42,900 --> 00:41:44,466  
So we're beginning to know  
where the highways

973  
00:41:44,466 --> 00:41:47,433  
that we have to watch where  
humans might be gathering.

974  
00:41:47,433 --> 00:41:49,366  
We'll use this satellite data

975  
00:41:49,366 --> 00:41:52,600  
to make the synthesis of taking  
all the data that we have,

976  
00:41:52,600 --> 00:41:54,433  
putting it together  
with GAM models,

977  
00:41:54,433 --> 00:41:56,700  
and asking the question,  
what is it that structures

978  
00:41:56,700 --> 00:41:57,933  
the habitat?

979  
00:41:57,933 --> 00:41:59,700  
How is it that temperature  
and chlorophyll

980  
00:41:59,700 --> 00:42:01,733  
are structuring these places?

981  
00:42:01,733 --> 00:42:02,966  
And then we'll

look at something

982

00:42:02,966 --> 00:42:06,733

like our elephant seal  
or pinniped information

983

00:42:06,733 --> 00:42:08,966

and we'll take this  
to a step further

984

00:42:08,966 --> 00:42:10,400

where it helps the planet Earth

985

00:42:10,400 --> 00:42:12,700

where the data that  
we're gathering as--as--

986

00:42:12,700 --> 00:42:14,666

as biologists now

987

00:42:14,666 --> 00:42:16,700

as the animals move up and down

988

00:42:16,700 --> 00:42:20,866

is being sent to the world,  
you know, GTS data set

989

00:42:20,866 --> 00:42:23,800

and the animals themselves,  
as they cross the Pacific

990

00:42:23,800 --> 00:42:25,166

and come back with their tags

991

00:42:25,166 --> 00:42:27,700

can actually take more data

992

00:42:27,700 --> 00:42:30,900

than any manmade automated

vehicle at a lower cost,

993

00:42:30,900 --> 00:42:32,766

you know, the cost  
of a sardine or two,

994

00:42:32,766 --> 00:42:36,433

across the entire ocean basin.

995

00:42:36,433 --> 00:42:38,966

All right, so this Animals  
as Ocean Sensors project

996

00:42:38,966 --> 00:42:40,633

is something that's grown up  
out of TOPP.

997

00:42:40,633 --> 00:42:42,033

It's happening  
across the planet.

998

00:42:42,033 --> 00:42:45,300

What we do as  
animal oceanographers

999

00:42:45,300 --> 00:42:47,066

is we take our data,  
we're learning to strip

1000

00:42:47,066 --> 00:42:50,333

the ocean data from it,  
send it up to the world system

1001

00:42:50,333 --> 00:42:53,366

so that we can have a better  
view of that in situ look

1002

00:42:53,366 --> 00:42:56,700

at the oceans, such that if  
this is last year's El Niño--

1003

00:42:56,700 --> 00:42:59,266

this is my colleague

Dan Costa's team--

1004

00:42:59,266 --> 00:43:01,666

where we're sending out

the elephant seals

1005

00:43:01,666 --> 00:43:04,133

to see the warm blob

that developed.

1006

00:43:04,133 --> 00:43:07,166

And you look at, you know,

the Argo float program,

1007

00:43:07,166 --> 00:43:08,700

a well-funded oceanographic

program,

1008

00:43:08,700 --> 00:43:10,666

and the red are the hot areas,

1009

00:43:10,666 --> 00:43:13,533

of how much data is coming back

in terms of casts,

1010

00:43:13,533 --> 00:43:15,300

the seals, for a very low cost,

1011

00:43:15,300 --> 00:43:17,866

can actually generate

quite a bit of data.

1012

00:43:17,866 --> 00:43:21,033

This has really been taken

to heart at the Arctic

1013

00:43:21,033 --> 00:43:23,666  
and Antarctic zones  
where those are animal tags

1014  
00:43:23,666 --> 00:43:27,000  
from five nations in  
the MEOP program being put out,

1015  
00:43:27,000 --> 00:43:29,566  
versus the Argo floats in red,

1016  
00:43:29,566 --> 00:43:31,266  
which can't really get  
to some of the places

1017  
00:43:31,266 --> 00:43:32,800  
that the animals can get to.

1018  
00:43:32,800 --> 00:43:36,333  
So animals are being cohorts in  
oceanography across the planet.

1019  
00:43:36,333 --> 00:43:39,033  
I want to just tell you  
just a few more stories.

1020  
00:43:39,033 --> 00:43:41,766  
This is a satellite tag  
on a shark.

1021  
00:43:41,766 --> 00:43:43,466  
We didn't know when we started  
we could send data

1022  
00:43:43,466 --> 00:43:45,333  
from the fin of a shark.

1023  
00:43:45,333 --> 00:43:48,666  
This is coming down  
from Alaska,

1024

00:43:48,666 --> 00:43:51,766

a salmon shark really roving  
over the northeast Pacific.

1025

00:43:51,766 --> 00:43:54,433

Here's a mako  
over three years

1026

00:43:54,433 --> 00:43:56,900

tagged here,  
one year, two years,

1027

00:43:56,900 --> 00:43:59,233

and the third year,  
and then today, off the web...

1028

00:43:59,233 --> 00:44:01,466

this is this morning.

1029

00:44:01,466 --> 00:44:04,033

A salmon shark we tagged last  
year or a year ago in Alaska

1030

00:44:04,033 --> 00:44:05,566

is right in Monterey Bay.

1031

00:44:05,566 --> 00:44:08,466

I might go out and see  
that shark this weekend.

1032

00:44:08,466 --> 00:44:11,400

So we, again,  
another story here,

1033

00:44:11,400 --> 00:44:13,966

learned about this whole other  
cousin of white sharks.

1034

00:44:13,966 --> 00:44:16,766

Their enormous migrations  
with satellite tags.

1035

00:44:16,766 --> 00:44:18,766

They're--this is the population  
on the right,

1036

00:44:18,766 --> 00:44:21,666

a single individual on the--  
on the left.

1037

00:44:21,666 --> 00:44:23,166

And you know, I would argue  
that we don't have

1038

00:44:23,166 --> 00:44:25,333

polar bear tracks for this  
long, again, from technology

1039

00:44:25,333 --> 00:44:28,233

that is allowing us  
to figure out where they are

1040

00:44:28,233 --> 00:44:30,433

and what their impact are  
on salmon.

1041

00:44:30,433 --> 00:44:31,933

And then the one that everybody  
wants to hear about

1042

00:44:31,933 --> 00:44:33,833

are the white sharks  
in our backyard.

1043

00:44:33,833 --> 00:44:36,066

Two tags, acoustic and pop-up.

1044

00:44:36,066 --> 00:44:37,833

Everybody wants to know  
how we do it.

1045  
00:44:37,833 --> 00:44:39,600  
We bring 'em close to the boat.

1046  
00:44:39,600 --> 00:44:41,600  
We don't recommend  
you do this at home.

1047  
00:44:41,600 --> 00:44:43,833  
And when you bring a white  
shark close to the boat,

1048  
00:44:43,833 --> 00:44:47,100  
you can attract them  
with a seal decoy

1049  
00:44:47,100 --> 00:44:48,933  
and a piece of blubber.

1050  
00:44:48,933 --> 00:44:52,966  
You can get the animal moving  
right into the boat area,

1051  
00:44:52,966 --> 00:44:55,466  
and if you put on a tag,  
like a satellite tag,

1052  
00:44:55,466 --> 00:44:58,866  
in red are individual tracks  
and in yellow

1053  
00:44:58,866 --> 00:45:00,800  
is the whole population.

1054  
00:45:00,800 --> 00:45:03,866  
That's how we learn that every  
shark here on California coast

1055

00:45:03,866 --> 00:45:06,066

is going offshore,  
back inshore,

1056

00:45:06,066 --> 00:45:09,466

and hanging out at places  
like the White Shark Café.

1057

00:45:09,466 --> 00:45:12,000

The depth information  
on the tag

1058

00:45:12,000 --> 00:45:15,366

gives us the incredible story  
that in close to shore,

1059

00:45:15,366 --> 00:45:16,666

this is what you're most  
interested in

1060

00:45:16,666 --> 00:45:18,000

for the surfers in the room,

1061

00:45:18,000 --> 00:45:19,466

they're right here  
at the surface.

1062

00:45:19,466 --> 00:45:22,266

Red being  
the high-occupancy areas.

1063

00:45:22,266 --> 00:45:25,266

Once they go offshore, they're  
doing a dial behavior

1064

00:45:25,266 --> 00:45:28,600

and in the café,  
my colleague, Sal Jorgensen,

1065

00:45:28,600 --> 00:45:31,900

has shown that they're doing  
a rapid oscillatory diving.

1066

00:45:31,900 --> 00:45:35,266

We think this could be  
behaviorally some sort of

1067

00:45:35,266 --> 00:45:38,233

behavior that's attracting  
males and females in the café.

1068

00:45:38,233 --> 00:45:41,533

So they're eating pinnipeds  
close to home,

1069

00:45:41,533 --> 00:45:43,966

squid offshore,  
and the café is the place

1070

00:45:43,966 --> 00:45:45,666

for meet and greet.

1071

00:45:45,666 --> 00:45:48,766

And in this café, we know very  
little that's happening there.

1072

00:45:48,766 --> 00:45:50,500

We know it's  
a concentrated place.

1073

00:45:50,500 --> 00:45:51,933

We haven't been there yet.

1074

00:45:51,933 --> 00:45:53,800

We can use satellites  
to look down on it.

1075

00:45:53,800 --> 00:45:55,866

And what we're doing right now

1076

00:45:55,866 --> 00:45:57,400  
with our Google colleagues

1077

00:45:57,400 --> 00:46:00,333  
is looking at who's in  
the café.

1078

00:46:00,333 --> 00:46:04,533  
This is now human fishing  
hours in the café using

1079

00:46:04,533 --> 00:46:08,066  
the AIS beacons to ask,  
"Who is in our Blue Serengeti?"

1080

00:46:08,066 --> 00:46:09,900  
And note there's very little  
activity

1081

00:46:09,900 --> 00:46:11,833  
in our North American ocean.

1082

00:46:11,833 --> 00:46:13,200  
That's good.

1083

00:46:13,200 --> 00:46:14,266  
All right, so I'll sum that up

1084

00:46:14,266 --> 00:46:16,300  
by showing  
all three species now.

1085

00:46:16,300 --> 00:46:19,466  
Makos, white sharks,  
salmon sharks

1086

00:46:19,466 --> 00:46:22,500  
all moving through space

and time in an ocean of color,

1087

00:46:22,500 --> 00:46:25,066

of temperature,

and we see the three species

1088

00:46:25,066 --> 00:46:27,900

and their shadows there

separated,

1089

00:46:27,900 --> 00:46:30,500

and basically the white sharks

out there in the café.

1090

00:46:30,500 --> 00:46:32,700

You could learn what time would

be a good time to go swimming

1091

00:46:32,700 --> 00:46:34,033

in Monterey.

1092

00:46:34,033 --> 00:46:35,733

April looks pretty good.

1093

00:46:35,733 --> 00:46:37,366

And then these sharks

are gonna come back

1094

00:46:37,366 --> 00:46:39,900

and you'll see that they'll

peak on our shore

1095

00:46:39,900 --> 00:46:43,300

right about--coming up in the--

in the summertime.

1096

00:46:43,300 --> 00:46:44,566

They just headed back.

1097

00:46:44,566 --> 00:46:46,600

The first shark  
showed up yesterday.

1098

00:46:46,600 --> 00:46:49,033

And then by November,  
all those white dots

1099

00:46:49,033 --> 00:46:51,000

are gonna be out of  
the open sea

1100

00:46:51,000 --> 00:46:54,233

and into the coastal ocean.

1101

00:46:55,766 --> 00:46:59,000

We sometimes have salmon sharks  
get eaten by white sharks.

1102

00:46:59,000 --> 00:47:00,733

That's a good story there.

1103

00:47:00,733 --> 00:47:03,066

All right, you can see the body  
temperature getting constant

1104

00:47:03,066 --> 00:47:04,666

and warm.

1105

00:47:04,666 --> 00:47:07,000

But the main story  
that I've told you today

1106

00:47:07,000 --> 00:47:09,566

is we are a team  
working with many others

1107

00:47:09,566 --> 00:47:12,600

discovered that we have  
a Blue Serengeti,

1108

00:47:12,600 --> 00:47:14,500

a place as equivalent to  
Kruger National Park

1109

00:47:14,500 --> 00:47:15,733

in our backyard.

1110

00:47:15,733 --> 00:47:17,166

All the animals are here.

1111

00:47:17,166 --> 00:47:19,300

We're trying now  
to raise awareness

1112

00:47:19,300 --> 00:47:21,800

of how do you make an MPA,  
a marine protected area,

1113

00:47:21,800 --> 00:47:23,866

that would protect this region

1114

00:47:23,866 --> 00:47:25,433

beyond the sanctuaries?

1115

00:47:25,433 --> 00:47:28,400

How is it that we make  
a Yellowstone in the ocean?

1116

00:47:28,400 --> 00:47:30,866

How do we make Yosemite  
in the ocean?

1117

00:47:30,866 --> 00:47:34,066

So there's a map  
of the great blue areas.

1118

00:47:34,066 --> 00:47:36,166

We call these the large

marine protected areas.

1119

00:47:36,166 --> 00:47:37,866

There are not very many  
in the ocean.

1120

00:47:37,866 --> 00:47:41,233

Less than 10% of the ocean  
is protected.

1121

00:47:41,233 --> 00:47:44,300

Here's the Phoenix Islands  
Protected Area, Chagos.

1122

00:47:44,300 --> 00:47:46,100

Here's our backyard,

1123

00:47:46,100 --> 00:47:49,000

not very well protected.

1124

00:47:49,000 --> 00:47:50,700

In order to protect  
these places

1125

00:47:50,700 --> 00:47:51,933

and look to the future,

1126

00:47:51,933 --> 00:47:56,200

we need to have  
apex predator monitoring.

1127

00:47:56,200 --> 00:48:00,100

To do that, cool technologies  
like Wave Gliders

1128

00:48:00,100 --> 00:48:02,766

and buoys are being used.

1129

00:48:02,766 --> 00:48:04,866

I'm gonna finish up by just giving a couple examples.

1130

00:48:04,866 --> 00:48:07,633

These are where the animals are from our satellite tags.

1131

00:48:07,633 --> 00:48:09,933

The black is where the protection zones are.

1132

00:48:09,933 --> 00:48:11,900

Those are the national marine sanctuaries

1133

00:48:11,900 --> 00:48:13,300

White are white sharks.

1134

00:48:13,300 --> 00:48:15,666

Don't get nervous when you see that slide.

1135

00:48:15,666 --> 00:48:17,933

Orange are the salmon sharks.

1136

00:48:17,933 --> 00:48:20,600

It's a shark-y backyard we have.

1137

00:48:20,600 --> 00:48:22,900

We live in peace in this backyard with our sharks.

1138

00:48:22,900 --> 00:48:26,900

We've developed a system in which we put receivers,

1139

00:48:26,900 --> 00:48:29,500

built by a company called VEMCO, in the ocean

1140

00:48:29,500 --> 00:48:31,100  
at just a few places.

1141

00:48:31,100 --> 00:48:33,666  
We can keep track acoustically  
of the white sharks

1142

00:48:33,666 --> 00:48:35,200  
as they come and go.

1143

00:48:35,200 --> 00:48:38,333  
Those are just different white  
sharks hitting the receivers.

1144

00:48:38,333 --> 00:48:41,633  
We've put iridium satellite  
devices on the top

1145

00:48:41,633 --> 00:48:42,900  
of our receivers now,

1146

00:48:42,900 --> 00:48:45,300  
and you on your iPhone  
can keep track,

1147

00:48:45,300 --> 00:48:46,666  
and if you come  
into our app

1148

00:48:46,666 --> 00:48:48,633  
or take a look on the web

1149

00:48:48,633 --> 00:48:51,233  
of when a white shark  
swims by the buoy.

1150

00:48:51,233 --> 00:48:52,833  
You can see when it's here.

1151

00:48:52,833 --> 00:48:55,600

This is--you can see the gap  
when they're away.

1152

00:48:55,600 --> 00:48:57,400

This is yesterday,

1153

00:48:57,400 --> 00:48:58,966

and I just noticed  
this white shark

1154

00:48:58,966 --> 00:49:00,766

just showed up on our coast.

1155

00:49:00,766 --> 00:49:02,933

So you can do that  
by going to [topp.org](http://topp.org)

1156

00:49:02,933 --> 00:49:04,533

and going to a buoy.

1157

00:49:04,533 --> 00:49:06,533

These buoys have  
physical oceanography.

1158

00:49:06,533 --> 00:49:09,866

They're built in collaboration  
with MBARI now,

1159

00:49:09,866 --> 00:49:12,800

and we've got a few of them  
in the ocean right at Hopkins.

1160

00:49:12,800 --> 00:49:14,633

We can tell our undergrads,  
"Hey, look,

1161

00:49:14,633 --> 00:49:18,433

there's 14 large white sharks  
that come by."

1162  
00:49:18,433 --> 00:49:20,433  
The gliders give us  
continuous coverage,

1163  
00:49:20,433 --> 00:49:23,166  
and the future of oceanography  
is to begin to enable

1164  
00:49:23,166 --> 00:49:25,766  
this mechanized world  
that samples

1165  
00:49:25,766 --> 00:49:29,966  
allows us to go in, do things  
like go around Farallones

1166  
00:49:29,966 --> 00:49:32,666  
and see with a mechanized  
glider, all in yellow,

1167  
00:49:32,666 --> 00:49:35,100  
that white sharks are  
circling the Farallones.

1168  
00:49:35,100 --> 00:49:37,966  
Not a great place to go  
swimming in the summertime.

1169  
00:49:37,966 --> 00:49:41,366  
That's a bunch of different  
white sharks all gathered there

1170  
00:49:41,366 --> 00:49:43,533  
that we couldn't visualize  
ourselves

1171  
00:49:43,533 --> 00:49:45,700

until we had gliders  
that were circling.

1172  
00:49:45,700 --> 00:49:48,866  
So in conclusion,  
the future really is

1173  
00:49:48,866 --> 00:49:51,666  
a future in which  
we bring together

1174  
00:49:51,666 --> 00:49:53,566  
these disparate worlds of--

1175  
00:49:53,566 --> 00:49:55,966  
of surveillance,

1176  
00:49:55,966 --> 00:49:58,833  
technologies that are  
latecomers to our oceans

1177  
00:49:58,833 --> 00:50:01,133  
that you probably are using on  
other planetary missions.

1178  
00:50:01,133 --> 00:50:02,733  
And we begin to understand

1179  
00:50:02,733 --> 00:50:05,833  
how is it that we can see  
what's happening in our sea?

1180  
00:50:05,833 --> 00:50:07,566  
And that's what  
we're trying to do

1181  
00:50:07,566 --> 00:50:10,033  
with our colleagues right now.

1182

00:50:10,033 --> 00:50:12,500

And the future  
is something like having

1183

00:50:12,500 --> 00:50:13,666

not only  
the mechanized vehicles

1184

00:50:13,666 --> 00:50:15,066

and the tagged animals,

1185

00:50:15,066 --> 00:50:18,200

but also developing this world  
of environmental DNA,

1186

00:50:18,200 --> 00:50:20,166

being able to do signatures

1187

00:50:20,166 --> 00:50:22,400

of being able to see where  
the animals are,

1188

00:50:22,400 --> 00:50:23,933

and also pick up  
their signature

1189

00:50:23,933 --> 00:50:25,900

from their genetic material.

1190

00:50:25,900 --> 00:50:29,066

So an evolving area of science  
is the fact that

1191

00:50:29,066 --> 00:50:30,833

wherever you go,  
especially in the sea,

1192

00:50:30,833 --> 00:50:34,000

you can find the shedding cells  
and tell who's been there.

1193

00:50:34,000 --> 00:50:36,566

We envision the day soon

1194

00:50:36,566 --> 00:50:40,466

where we could just send out  
a glider to the café

1195

00:50:40,466 --> 00:50:43,100

and the glider remotely could  
sample what's happening there

1196

00:50:43,100 --> 00:50:44,733

and send it back to the lab.

1197

00:50:44,733 --> 00:50:46,833

Something you'd be doing  
on Mars, perhaps.

1198

00:50:46,833 --> 00:50:48,800

And then we envision  
the day soon

1199

00:50:48,800 --> 00:50:51,266

where we take back our seas  
from the poachers

1200

00:50:51,266 --> 00:50:54,666

that with the Google  
and SkyTruth-enabled ability

1201

00:50:54,666 --> 00:50:57,166

to follow where humans are

1202

00:50:57,166 --> 00:50:59,200

that we can actually,  
in these remote places,

1203

00:50:59,200 --> 00:51:01,133

the largest MPAs on Earth,

1204

00:51:01,133 --> 00:51:03,800

build the type of devices  
that help us prevent

1205

00:51:03,800 --> 00:51:06,200

the taking of the sharks.

1206

00:51:06,200 --> 00:51:09,433

I'm gonna just go back--back  
right past this very sad story,

1207

00:51:09,433 --> 00:51:12,500

the largest MPA on Earth  
where we work,

1208

00:51:12,500 --> 00:51:15,666

completely overrun with  
poachers that we can't stop.

1209

00:51:15,666 --> 00:51:18,733

And I'll end on this last note.

1210

00:51:18,733 --> 00:51:20,866

My hope for the future is that

1211

00:51:20,866 --> 00:51:23,266

with coming together of  
different groups,

1212

00:51:23,266 --> 00:51:26,033

we can do things like build  
what we're building right now

1213

00:51:26,033 --> 00:51:27,933

with our Stanford colleagues  
and aerospace,

1214

00:51:27,933 --> 00:51:29,766  
the fin alert shark tag,

1215  
00:51:29,766 --> 00:51:32,233  
a tag that, when we take a shark  
from the sea,

1216  
00:51:32,233 --> 00:51:34,433  
it will have the same type  
of device we have

1217  
00:51:34,433 --> 00:51:36,666  
in clothes at Macy's

1218  
00:51:36,666 --> 00:51:40,866  
where it will alert  
the patrol boats

1219  
00:51:40,866 --> 00:51:42,566  
that the animal's been taken

1220  
00:51:42,566 --> 00:51:44,200  
and the patrol boat can come  
and say, hey,

1221  
00:51:44,200 --> 00:51:46,733  
you know, you're not  
supposed to be in our MPA,

1222  
00:51:46,733 --> 00:51:48,066  
our marine protected area.

1223  
00:51:48,066 --> 00:51:50,433  
That type of technology  
is what we need

1224  
00:51:50,433 --> 00:51:52,166  
combined with  
the satellite technology

1225  
00:51:52,166 --> 00:51:54,566  
to own this place called Earth

1226  
00:51:54,566 --> 00:51:55,933  
and to prevent  
what's happening,

1227  
00:51:55,933 --> 00:51:59,566  
the decimation of  
the large marine predators

1228  
00:51:59,566 --> 00:52:03,033  
in the open sea  
beyond U.S. borders.

1229  
00:52:03,033 --> 00:52:06,166  
So I'm gonna end  
by saying thanks for listening.

1230  
00:52:06,166 --> 00:52:08,233  
Monitoring with technology,

1231  
00:52:08,233 --> 00:52:10,766  
bringing together  
these disparate paths

1232  
00:52:10,766 --> 00:52:13,133  
is really the future  
of our oceans,

1233  
00:52:13,133 --> 00:52:14,866  
and to do all this work,

1234  
00:52:14,866 --> 00:52:17,000  
there's many people  
I would have to thank

1235  
00:52:17,000 --> 00:52:18,833  
but I particularly want to

thank my own laboratory

1236

00:52:18,833 --> 00:52:21,133

that actually has led  
the charge with me

1237

00:52:21,133 --> 00:52:22,933

throughout the years,  
many different people,

1238

00:52:22,933 --> 00:52:25,100

and then the combination of  
philanthropic

1239

00:52:25,100 --> 00:52:26,733

and federal funding  
that's allowed us

1240

00:52:26,733 --> 00:52:28,833

to span two ocean basins

1241

00:52:28,833 --> 00:52:31,566

in pursuit of a healthier ocean.

1242

00:52:31,566 --> 00:52:33,033

Thank you very much.

1243

00:52:33,033 --> 00:52:36,033

[applause]

1244

00:52:39,100 --> 00:52:40,833

- Great talk.

1245

00:52:40,833 --> 00:52:42,933

So we have time  
for a few questions.

1246

00:52:42,933 --> 00:52:44,566

If you have a question,

please raise your hand,

1247

00:52:44,566 --> 00:52:46,766

wait for the microphone,  
stand up,

1248

00:52:46,766 --> 00:52:49,333

and one question only.

1249

00:52:51,500 --> 00:52:54,000

- Hi, thank you for the talk.

That was great.

1250

00:52:54,000 --> 00:52:56,300

I'm wondering, when you're  
making these global conclusions

1251

00:52:56,300 --> 00:52:58,966

on fish trends,

1252

00:52:58,966 --> 00:53:01,533

how do you deal with the  
potential for oversampling

1253

00:53:01,533 --> 00:53:05,166

of fish in this region  
and maybe under-sampling

1254

00:53:05,166 --> 00:53:08,466

of populations that are  
based in Latin America

1255

00:53:08,466 --> 00:53:10,033

or Australia?

1256

00:53:10,033 --> 00:53:13,000

- Okay, so I'm gonna--  
I'm not entirely sure exactly

1257

00:53:13,000 --> 00:53:16,100  
which particular aspect  
of the study

1258  
00:53:16,100 --> 00:53:17,633  
you're--you're--  
you're focused on,

1259  
00:53:17,633 --> 00:53:19,533  
but let me just talk about  
fish trends.

1260  
00:53:19,533 --> 00:53:24,500  
The fish in the world  
are reported to

1261  
00:53:24,500 --> 00:53:26,433  
regional fishery management  
organizations

1262  
00:53:26,433 --> 00:53:29,200  
that are international  
called RFMOs or to FAO.

1263  
00:53:29,200 --> 00:53:31,833  
And so most of the grids  
for fish reporting

1264  
00:53:31,833 --> 00:53:35,533  
are five-by-five grids,

1265  
00:53:35,533 --> 00:53:37,700  
and all you're getting is what  
humans tell other humans

1266  
00:53:37,700 --> 00:53:38,933  
they're doing.

1267  
00:53:38,933 --> 00:53:40,566  
So there's a lot of

illegal fishing, too,

1268

00:53:40,566 --> 00:53:42,033  
but most of what you're seeing  
in graphs

1269

00:53:42,033 --> 00:53:44,366  
is reported fishing pressure.

1270

00:53:44,366 --> 00:53:46,633  
And there's been study after  
study across the planet

1271

00:53:46,633 --> 00:53:49,700  
that's shown that the trends  
are, you know, going down.

1272

00:53:49,700 --> 00:53:52,700  
It's called the fishing down  
of the food web.

1273

00:53:54,633 --> 00:53:56,033  
- I mean, more of when  
you're tagging fish,

1274

00:53:56,033 --> 00:53:57,033  
how do you--how do you  
deal with--

1275

00:53:57,033 --> 00:53:58,400  
- Wait for the mic.

1276

00:53:58,400 --> 00:54:01,300  
- Tagging only ones that are in  
this area, or tagging sharks--

1277

00:54:01,300 --> 00:54:02,900  
- Okay, sorry.

1278

00:54:02,900 --> 00:54:05,400

When we tag and we look at  
where an animal goes,

1279

00:54:05,400 --> 00:54:08,666

we have to actually account  
for that tagging area.

1280

00:54:08,666 --> 00:54:13,100

So we either have to do a  
statistical, robust analysis

1281

00:54:13,100 --> 00:54:16,566

in which we have to measure  
how many animals do we tag,

1282

00:54:16,566 --> 00:54:18,433

what was the length of a tag on,

1283

00:54:18,433 --> 00:54:20,833

how do we deal with dispersion  
versus advection,

1284

00:54:20,833 --> 00:54:24,066

so it's just a math model.

1285

00:54:24,066 --> 00:54:26,333

I'm not--maybe I didn't get  
your question exactly.

1286

00:54:26,333 --> 00:54:29,133

- Hi, that was fascinating.

I have two questions.

1287

00:54:29,133 --> 00:54:32,400

The first question is,  
when the animals are going out

1288

00:54:32,400 --> 00:54:34,700

way offshore,

they're crossing deserts.

1289

00:54:34,700 --> 00:54:37,166

I mean, are they going deep?

1290

00:54:37,166 --> 00:54:41,166

I mean, are they--their surface waters are oligotrophic,

1291

00:54:41,166 --> 00:54:43,266

so how are they managing?

1292

00:54:43,266 --> 00:54:45,533

And they don't seem to be following currents.

1293

00:54:45,533 --> 00:54:47,233

They seem to be going countercurrents.

1294

00:54:47,233 --> 00:54:49,633

So what have you learned about that aspect?

1295

00:54:49,633 --> 00:54:51,033

And then I have another question.

1296

00:54:51,033 --> 00:54:52,933

- I think that's-- that's a really great question.

1297

00:54:52,933 --> 00:54:55,200

That's sort of the secret of the planet Earth.

1298

00:54:55,200 --> 00:54:57,400

So the biggest peanut butter shop on the planet

1299

00:54:57,400 --> 00:54:59,433

is in what we call  
the mesopelagic,

1300

00:54:59,433 --> 00:55:02,033

so that's the layer  
underneath the open sea,

1301

00:55:02,033 --> 00:55:03,800

so the pelagic.

1302

00:55:03,800 --> 00:55:07,566

And in that layer is  
a fish with oil

1303

00:55:07,566 --> 00:55:09,800

that may be the real  
peanut butter of the sea

1304

00:55:09,800 --> 00:55:11,333

called a lantern fish.

1305

00:55:11,333 --> 00:55:12,900

So a lot of these animals  
are diving down

1306

00:55:12,900 --> 00:55:15,600

to that layer that  
doesn't have light,

1307

00:55:15,600 --> 00:55:17,566

the mesopelagic,  
or it's got low light,

1308

00:55:17,566 --> 00:55:21,700

feeding in that sometimes  
low-oxygen layer,

1309

00:55:21,700 --> 00:55:22,966

sometimes not low-oxygen,

1310

00:55:22,966 --> 00:55:24,300  
and then coming back  
to the surface.

1311

00:55:24,300 --> 00:55:27,466  
So we see a lot of that  
dial behavior

1312

00:55:27,466 --> 00:55:29,266  
out in the open sea,

1313

00:55:29,266 --> 00:55:31,100  
and so there's--

1314

00:55:31,100 --> 00:55:33,200  
there's three parts to  
the answer to your question

1315

00:55:33,200 --> 00:55:35,266  
that--that we studied today.

1316

00:55:35,266 --> 00:55:38,133  
How are these animals  
so efficient in moving?

1317

00:55:38,133 --> 00:55:40,300  
That is, how is it that  
they don't have

1318

00:55:40,300 --> 00:55:42,166  
such high energetic costs  
that they can do that?

1319

00:55:42,166 --> 00:55:45,533  
They can use planetary scales  
that we could only dream of

1320

00:55:45,533 --> 00:55:48,066  
with a Rover or an AUV.

1321  
00:55:48,066 --> 00:55:51,600  
So every AUV on the planet,  
what limits where it goes?

1322  
00:55:51,600 --> 00:55:53,833  
Anybody?

1323  
00:55:53,833 --> 00:55:55,066  
Batteries, right?  
- Yeah.

1324  
00:55:55,066 --> 00:55:57,466  
- Okay, so unless you have  
a solar-powered AUV,

1325  
00:55:57,466 --> 00:55:59,966  
you can't go very far on  
the planet compared to a tuna.

1326  
00:55:59,966 --> 00:56:02,233  
And so what the animals  
are doing

1327  
00:56:02,233 --> 00:56:04,433  
is they're combining  
elastic energy storage

1328  
00:56:04,433 --> 00:56:07,466  
with mechanical muscle power.

1329  
00:56:07,466 --> 00:56:10,200  
Once they get out there,  
it's a desert.

1330  
00:56:10,200 --> 00:56:11,933  
So the question really is  
where do you feed?

1331

00:56:11,933 --> 00:56:13,833

And the answer is  
you're feeding below

1332

00:56:13,833 --> 00:56:16,833

the surface satellite imagery.

1333

00:56:16,833 --> 00:56:18,800

And I think the café is  
a great example

1334

00:56:18,800 --> 00:56:20,666

where, you know,

1335

00:56:20,666 --> 00:56:22,866

by surface signal,  
we would never know that

1336

00:56:22,866 --> 00:56:25,366

that was a place that all  
the white sharks gather,

1337

00:56:25,366 --> 00:56:27,100

or would we know why.

1338

00:56:27,100 --> 00:56:28,800

And so when we go there  
physically

1339

00:56:28,800 --> 00:56:30,200

perhaps for the first time--

1340

00:56:30,200 --> 00:56:31,666

we've applied for  
some cruise time--

1341

00:56:31,666 --> 00:56:34,700

maybe what we'll find

is what I think is going on,

1342

00:56:34,700 --> 00:56:37,766

and that is that  
there is an edge there

1343

00:56:37,766 --> 00:56:39,933

that we don't naturally  
recognize as vertebrates,

1344

00:56:39,933 --> 00:56:41,166

as primates.

1345

00:56:41,166 --> 00:56:44,400

The edge is formed by  
a hypoxic layer

1346

00:56:44,400 --> 00:56:47,866

and a very well-oxygenated  
piece of the ocean

1347

00:56:47,866 --> 00:56:49,733

and maybe along  
that frontal boundary,

1348

00:56:49,733 --> 00:56:51,166

that's a kind of  
frontal boundary

1349

00:56:51,166 --> 00:56:52,733

that we don't normally see  
from the surface,

1350

00:56:52,733 --> 00:56:56,066

there's a stack of, like,  
cordwood of prey

1351

00:56:56,066 --> 00:56:57,400

or maybe it's for  
some other reason,

1352

00:56:57,400 --> 00:56:59,200

but I think what the animals  
are teaching us

1353

00:56:59,200 --> 00:57:02,366

is we don't entirely yet  
understand our planet

1354

00:57:02,366 --> 00:57:05,733

as to where the carbon  
gets stored

1355

00:57:05,733 --> 00:57:08,300

that then makes for  
a good food web.

1356

00:57:08,300 --> 00:57:09,500

- Well, that's interesting.

1357

00:57:09,500 --> 00:57:11,200

There may also be  
some metabolic issues

1358

00:57:11,200 --> 00:57:12,933

because it's a lower  
temperature,

1359

00:57:12,933 --> 00:57:14,300

but the following question  
I have

1360

00:57:14,300 --> 00:57:17,600

is that the ocean is  
an acoustic environment,

1361

00:57:17,600 --> 00:57:19,266

not a visual environment.

1362

00:57:19,266 --> 00:57:22,566

Have you thought about look--  
listening to the animals

1363

00:57:22,566 --> 00:57:24,133

as they're moving through  
the ocean,

1364

00:57:24,133 --> 00:57:27,100

and not only to understand  
what they're doing,

1365

00:57:27,100 --> 00:57:29,966

but also to learn about  
the surrounding environment

1366

00:57:29,966 --> 00:57:31,500

acoustically?

1367

00:57:31,500 --> 00:57:33,600

- Yeah, it's a superb question.

1368

00:57:33,600 --> 00:57:35,633

I'd say that we vertebrate  
researchers, especially in fish,

1369

00:57:35,633 --> 00:57:37,333

are behind on the acoustics.

1370

00:57:37,333 --> 00:57:38,900

We actually, for the Navy,  
did a project

1371

00:57:38,900 --> 00:57:40,633

where we measured tuna's  
capacity to hear.

1372

00:57:40,633 --> 00:57:43,066

It's quite good.

1373

00:57:43,066 --> 00:57:46,133

And so I think what probably  
is going on

1374

00:57:46,133 --> 00:57:49,166

that we haven't ever put  
a perception on

1375

00:57:49,166 --> 00:57:51,400

in terms of a human perception  
of how it works

1376

00:57:51,400 --> 00:57:54,333

is that certainly when things  
move through the ocean

1377

00:57:54,333 --> 00:57:57,000

there's sound signals, right?

1378

00:57:57,000 --> 00:57:59,200

How a fish would pick that up  
isn't something

1379

00:57:59,200 --> 00:58:03,000

anybody's, you know, done at  
the pelagic level very well,

1380

00:58:03,000 --> 00:58:06,066

but perhaps--  
perhaps it's working.

1381

00:58:06,066 --> 00:58:08,566

I think that smell  
is certainly big.

1382

00:58:08,566 --> 00:58:11,700

You look at a marlin,  
a tuna, swordfish,

1383

00:58:11,700 --> 00:58:14,966  
they've got a very large rosette  
that is nasal.

1384  
00:58:14,966 --> 00:58:18,133  
So clearly,  
the smell of a squid,

1385  
00:58:18,133 --> 00:58:20,800  
you know, may be something  
they can pick up.

1386  
00:58:20,800 --> 00:58:23,466  
I mean, I get fascinated  
primarily by simple questions

1387  
00:58:23,466 --> 00:58:26,700  
like this: how does a giant tuna  
swimming in the North Atlantic

1388  
00:58:26,700 --> 00:58:28,833  
decide to go to 1,000 meters

1389  
00:58:28,833 --> 00:58:31,566  
and do it in less than  
ten minutes?

1390  
00:58:31,566 --> 00:58:33,033  
You know, how did it know

1391  
00:58:33,033 --> 00:58:35,133  
that there was something  
worth chasing down there?

1392  
00:58:35,133 --> 00:58:38,266  
So how does it find the squid  
that's down there?

1393  
00:58:38,266 --> 00:58:39,966  
And wouldn't you love to see

from a camera

1394

00:58:39,966 --> 00:58:41,433

what's really going on?

1395

00:58:41,433 --> 00:58:43,966

Imagine all of you

who spend every day

1396

00:58:43,966 --> 00:58:46,133

wanting to go

to some other planet,

1397

00:58:46,133 --> 00:58:50,133

we've barely seen what's on

this planet at depth,

1398

00:58:50,133 --> 00:58:51,633

all right?

1399

00:58:51,633 --> 00:58:53,500

We've been to

the Marianas Trench.

1400

00:58:53,500 --> 00:58:55,566

We've been to some of

these incredible places,

1401

00:58:55,566 --> 00:58:58,266

but do we really understand

1402

00:58:58,266 --> 00:58:59,466

places like the open sea,

1403

00:58:59,466 --> 00:59:02,233

what's happening in the richest,

1404

00:59:02,233 --> 00:59:04,433

most biodiverse region,

the mesopelagic,

1405

00:59:04,433 --> 00:59:07,866  
which covers the largest zone  
of the ocean?

1406

00:59:07,866 --> 00:59:10,033  
So we oceanographers  
have been behind

1407

00:59:10,033 --> 00:59:12,166  
at sending our message out.

1408

00:59:12,166 --> 00:59:14,366  
We're perhaps not as articulate  
a crowd

1409

00:59:14,366 --> 00:59:16,966  
as our colleagues  
of this institution,

1410

00:59:16,966 --> 00:59:20,833  
and I think that, you know,  
there's some really clear issues

1411

00:59:20,833 --> 00:59:23,933  
across 2/3 of the planet  
that have to be sorted out.

1412

00:59:23,933 --> 00:59:26,333  
And I think that, you know,  
it's challenging

1413

00:59:26,333 --> 00:59:29,333  
to make it compelling.

1414

00:59:31,900 --> 00:59:34,866  
- Hi, thanks for coming  
to talk to us.

1415

00:59:34,866 --> 00:59:36,700

I had a question in terms of--  
you talked about

1416

00:59:36,700 --> 00:59:38,633

a lot of different technologies  
that are being developed.

1417

00:59:38,633 --> 00:59:42,266

In terms of one  
establishing MPAs

1418

00:59:42,266 --> 00:59:44,933

across--for California,

1419

00:59:44,933 --> 00:59:48,366

and then sort of supporting  
the establishment

1420

00:59:48,366 --> 00:59:50,100

and retaining them,

1421

00:59:50,100 --> 00:59:52,633

what types of advancements  
in technologies

1422

00:59:52,633 --> 00:59:54,500

or developments do you see?

1423

00:59:54,500 --> 00:59:57,300

Is it sort of supporting, like,  
population

1424

00:59:57,300 --> 01:00:00,100

or looking at species or--

1425

01:00:00,100 --> 01:00:02,533

maybe you could speak  
a little bit to that.

1426

01:00:02,533 --> 01:00:04,933

- Okay, and that's a--  
that's a terrific question,

1427

01:00:04,933 --> 01:00:06,300

a very hard question, too,

1428

01:00:06,300 --> 01:00:08,466

so thank you for  
the difficult question.

1429

01:00:08,466 --> 01:00:12,133

And I don't think we have  
a clear answer to that question.

1430

01:00:12,133 --> 01:00:14,666

I think that many of you  
may know that

1431

01:00:14,666 --> 01:00:16,766

there's been an act passed  
in California

1432

01:00:16,766 --> 01:00:19,766

that protects  
very important domains

1433

01:00:19,766 --> 01:00:21,233

that are inshore,

1434

01:00:21,233 --> 01:00:22,600

so the Marine Life  
Protection Act.

1435

01:00:22,600 --> 01:00:25,533

That means that a hundred years  
from now,

1436

01:00:25,533 --> 01:00:27,866

you know, your kids' kids  
might be able to see

1437

01:00:27,866 --> 01:00:30,833

what happens in a California  
intertidal zone

1438

01:00:30,833 --> 01:00:32,433

that's almost undisturbed.

1439

01:00:32,433 --> 01:00:35,033

So it protects small places  
close to shore.

1440

01:00:35,033 --> 01:00:38,466

We have sanctuaries now,  
and these sanctuaries,

1441

01:00:38,466 --> 01:00:40,633

such as Monterey Bay  
National Marine Sanctuary,

1442

01:00:40,633 --> 01:00:42,333

the Gulf of the Farallones  
Sanctuary,

1443

01:00:42,333 --> 01:00:44,366

Cordell Bank Sanctuary,

1444

01:00:44,366 --> 01:00:46,466

they protect larger parcels  
of the ocean

1445

01:00:46,466 --> 01:00:48,200

that are quite important,

1446

01:00:48,200 --> 01:00:49,866

but they still allow fishing

1447

01:00:49,866 --> 01:00:52,633

and many activities  
to occur there.

1448

01:00:52,633 --> 01:00:55,533

There is a push going on  
right now

1449

01:00:55,533 --> 01:01:00,366

by--by the west-coast folks

1450

01:01:00,366 --> 01:01:04,900

in--in oceans  
to now take seamounts

1451

01:01:04,900 --> 01:01:08,066

and through the Monument Act

1452

01:01:08,066 --> 01:01:11,300

put those out of reach  
of certain types of fishers,

1453

01:01:11,300 --> 01:01:13,733

the fishers who can drag a net  
along a seamount

1454

01:01:13,733 --> 01:01:16,200

and change the biodiversity  
overnight.

1455

01:01:16,200 --> 01:01:18,033

So that is an--

1456

01:01:18,033 --> 01:01:20,700

is an Antiquities Act type  
of protection

1457

01:01:20,700 --> 01:01:24,066

that may go in play at the end

of the Obama administration.

1458

01:01:25,533 --> 01:01:28,633

What other tools do we have  
to protect pelagic areas?

1459

01:01:28,633 --> 01:01:30,300

Very few is the answer.

1460

01:01:30,300 --> 01:01:33,566

Even building  
a World Heritage Site,

1461

01:01:33,566 --> 01:01:35,700

you know, the same type of site  
that might be around

1462

01:01:35,700 --> 01:01:37,300

the Great Barrier Reef,

1463

01:01:37,300 --> 01:01:41,266

is something that's very unique  
to a temperate zone like ours

1464

01:01:41,266 --> 01:01:44,400

and doesn't necessarily come  
with a lot of protection

1465

01:01:44,400 --> 01:01:47,033

as much as it raises the profile  
of an area.

1466

01:01:47,033 --> 01:01:50,000

So the answer is  
that's our challenge.

1467

01:01:50,000 --> 01:01:53,833

How do we tell the fleets  
of boats that we are seeing

1468

01:01:53,833 --> 01:01:56,500  
now that we have the AIS tools--

1469

01:01:56,500 --> 01:01:59,433  
so remember, the biggest tool  
that came of age

1470

01:01:59,433 --> 01:02:00,800  
in the last two years

1471

01:02:00,800 --> 01:02:05,700  
is the capacity to use  
a collision-avoidance system

1472

01:02:05,700 --> 01:02:08,100  
as a way to see what humans  
are doing on the planet,

1473

01:02:08,100 --> 01:02:11,800  
and it's been shocking to see  
all the nations

1474

01:02:11,800 --> 01:02:14,300  
out beyond our borders

1475

01:02:14,300 --> 01:02:17,000  
who are fishing every last fish  
they can get.

1476

01:02:17,000 --> 01:02:19,466  
So we may be the best  
at making laws

1477

01:02:19,466 --> 01:02:21,500  
that conserve and manage  
our fisheries.

1478

01:02:21,500 --> 01:02:23,766  
We do quite well as Americans.

1479

01:02:23,766 --> 01:02:24,933

But just beyond our borders,

1480

01:02:24,933 --> 01:02:26,866

where the animals

are coming in from,

1481

01:02:26,866 --> 01:02:29,466

we've got many nations,

1482

01:02:29,466 --> 01:02:32,066

and I'm not gonna name names,

but the fleets are big.

1483

01:02:32,066 --> 01:02:34,600

I'll name some of the biggest

fleets, China, Korea,

1484

01:02:34,600 --> 01:02:36,833

Japan.

1485

01:02:36,833 --> 01:02:39,600

And they're fishing

in the offshore realm.

1486

01:02:39,600 --> 01:02:42,733

So we won't save that part

of this planet

1487

01:02:42,733 --> 01:02:44,966

until we come up with ways

of monitoring,

1488

01:02:44,966 --> 01:02:47,166

and monitoring can only be done

with satellites

1489

01:02:47,166 --> 01:02:50,400

and with tools that  
would allow us to count,

1490  
01:02:50,400 --> 01:02:52,266  
you know, what's being taken.

1491  
01:02:52,266 --> 01:02:55,866  
So my dream is beyond the tag  
I told you about

1492  
01:02:55,866 --> 01:02:58,600  
unfunded--  
I call it fish chip--

1493  
01:02:58,600 --> 01:03:01,600  
is to chip the carcasses  
tomorrow,

1494  
01:03:01,600 --> 01:03:04,600  
not--not, you know,  
ten years from now.

1495  
01:03:04,600 --> 01:03:07,566  
So by chipping the carcasses  
with a satellite chip--

1496  
01:03:07,566 --> 01:03:09,300  
it isn't as easy as you think.

1497  
01:03:09,300 --> 01:03:11,000  
You want to have Veridium.

1498  
01:03:11,000 --> 01:03:14,100  
You want to have RFID.

1499  
01:03:14,100 --> 01:03:17,633  
You want to be able to see  
an animal in container ships,

1500

01:03:17,633 --> 01:03:20,200  
so you need GPS, Veridium, a  
bunch of different technologies

1501  
01:03:20,200 --> 01:03:21,866  
together on the chip

1502  
01:03:21,866 --> 01:03:24,466  
so that we can't have  
a black market of tuna,

1503  
01:03:24,466 --> 01:03:27,166  
toothfish, you know.

1504  
01:03:27,166 --> 01:03:29,200  
Other people might worry about  
rhinoceroses,

1505  
01:03:29,200 --> 01:03:31,433  
but you want to be able  
to chip the wildlife

1506  
01:03:31,433 --> 01:03:34,400  
so it can't be traveling  
the planet without us knowing.

1507  
01:03:34,400 --> 01:03:35,833  
And I think we could do that

1508  
01:03:35,833 --> 01:03:37,800  
as soon as people come together  
and say,

1509  
01:03:37,800 --> 01:03:41,133  
"We care about these problems."

1510  
01:03:41,133 --> 01:03:43,766  
- So with that, please join me  
in thanking Dr. Block

1511

01:03:43,766 --> 01:03:44,933

for an excellent talk.

1512

01:03:44,933 --> 01:03:46,633

[applause]